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EDITORIAL

THE present issue of this Journal embodies changes in setting and an addition to its title. The former adapts the Journal to the present need for economy and is a temporary expedient during the war; the latter avows a policy which the Journal has been actively pursuing during the past few years, and will remain a permanent feature. Had the times been more propitious, the change of title might have been made earlier; but we did not hesitate to put the policy into effect.

This policy is the outcome of our belief that there is need in this country for a journal of scientific stature devoted to diseases of the chest, a need which has been apparent for some time to those more especially concerned with the subject. Advances have been and are likely to continue to be rapid; and for those taking part in any special field, a journal aiming at a high standard of production for technical work in that field is an asset. Nowhere is this want more felt at present than with pulmonary diseases: there is no specialist journal in this country devoted to this branch of Medicine, and there are few abroad. Also it is a branch which calls for lavish illustration of important papers because of the particular eminence of radiography. Moreover, a special journal ought to fulfil other purposes: it should help to set a standard, to provide in readily accessible form a cross-section of present opinions and advances, and, by collected examples, to bring encouragement and stimulus to those who have the ability and opportunity to add to knowledge. It is the purpose and wish of those associated with this Journal that it may fulfil these tasks in future.

These aims are incompatible with restriction of the subject-matter of the Journal to any particular aspect of diseases of the chest. As tuberculous conditions are so greatly preponderant, papers dealing with them will certainly be in the majority—a fact worth emphasising in case those whose interests are principally in tuberculosis should feel that their special needs may become submerged. On the other hand, those dealing with chest diseases want familiarity with all pathological conditions of the chest, their diagnosis and treatment, even though they may be engaged chiefly upon care of the tuberculous.

To achieve balance it is wise to be inclusive, and a journal dealing with tuberculosis only cannot expect to achieve a wider aim. For this reason we have deliberately encouraged the publication in the Journal of papers on other aspects of diseases of the chest; with the change of title, we hope that those whose special interests are in these non-tuberculous conditions will be attracted increasingly to its columns. For a journal must depend upon the breadth of its scope and upon the writers who contribute to it, if it is to maintain a standard and serve the branch of the profession for whose benefit and instruction it is published.

C. H.

GENERAL ARTICLES

RESULTS OF THORACOPLASTY

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Introduction

A recent paper in this Journal (Price Thomas and Cleland, 1942) described the operation of thoracoplasty with extrafascial mobilisation, and its indications, complications and management. Certain minor modifications were introduced into the standard Semb thoracoplasty designed to increase the effectiveness of mobilisation and so improve the results.

The present paper reports the results of thoracoplasty in 120 cases treated by one of us during eight years, 1933-40 inclusive. They were consecutive cases, and with six exceptions were treated at the same hospital, so that conditions of management were uniform other than the exact form of operation. Three distinct types of thoracoplasty were used in this group of patients: the lateral thoracoplasty, the Semb thoracoplasty, and the modification of this form which we described in the former paper. As time went by certain impressions began to form about the comparative merits and demerits of these three operative measures; and although figures relating to this limited series are not intended to carry statistical importance, they seemed to us worth recording and reviewing as a record of our experience.

The latest assessment of the cases was done during 1941: thus the total period of observation after treatment varied with individuals from one to nine years. No less than 54 of the 120 patients were treated during 1939-40, including all those who had the Modified Semb operation. No attempt has been made, therefore, to compare the results of the three operations beyond a year from treatment.

In the tables classifying the operative procedures we have used the term "lateral thoracoplasty" to indicate those without mobilisation of the apex; "Semb" for those where portions of the upper three ribs only were removed with extrafascial mobilisation of the apex to the fourth rib; and "Modified Semb" for those where additional resection of small portions of the fourth and fifth ribs was done as well as more extensive mobilisation on the mediastinum and in the paravertebral sulcus. Early mortality, throughout, signifies death while the patient was in hospital and implies a minimum of four months from the time of the initial operation. Later mortality refers to death occurring at any time from then until the end of 1941 and includes death from any cause.

Results

Table I shows the early mortality in each year irrespective of the type of operative procedure.

TABLE I.—EARLY MORTALITY IN RELATION TO YEAR OF OPERATION (ALL CASES)

	Total Cases.	*Early Mortality.*
1933	2	1
1934	7	2
1935	6	0
1936	20	4
1937	15	2
1938	16	1
1939	7	0
1940	47	2
Total	120	12

Its chief feature is the steady decrease in the operative mortality experienced during the period under review. Of 52 cases operated upon between 1933 and 1937, 10 died within four months of operation; of 72 operated upon between 1938 and 1940 only 3 died in the same period. This reduction in the immediate operative risk is all the more striking because the early group was treated mainly by the less extensive lateral thoracoplasty, whereas the later group was treated almost exclusively by thoracoplasty with mobilisation. The same distinction emerges from Table II, which shows the mortality for the total series and for each of the three forms of operation.

TABLE II.—EARLY, LATER AND TOTAL MORTALITY FIGURES (ALL CASES)

	Total Cases.	*Early Mortality.*	*Later Mortality.*	*Total Mortality.*
Lateral thoracoplasty	20	3	4	7
Semb	72	8	8	16
Modified Semb	28	1	2	3
Total	120	12	14	26

It looks from this experience as though the greater severity of mobilisation additional to thoracoplasty does nothing to heighten the mortality risk. Even the more extensive Modified Semb operation has not been accompanied by any greater mortality, for the small group of 28 treated so far has fared better than any other.

Table III deals with the mortalities, from all forms of operative procedure, among patients arranged in the three categories of "stationary chronic," "relapsing chronic" and "slipping chronic," categories already discussed in our previous paper. This classification has been used as it gives an indication of the course of the disease; in our opinion this is more important than the extent or age of the disease in planning the operation. We have rejected the terms "good," "bad" and "justifiable" risks, as they are too vague and give no idea of the patient's condition in relationship to his disease.

TABLE III.—COURSE OF DISEASE IN RELATION TO MORTALITY

	Total Cases.	*Early Mortality.*	*Later Mortality.*	*Total Mortality.*
Stationary chronic	37	1	2	3
Relapsing chronic	64	5	7	12
Slipping chronic	19	6	5	11

The *stationary chronic* is a stable case, not undergoing exacerbations and remissions of disease; pyrexia is uncommon, and there are little or no signs of toxæmia. The *relapsing chronic* resembles the stationary case at times, but has intermittent bouts of pyrexia, toxic symptoms, increase in cough and sputum and loss of weight. Recovery is usual, though the original state may not be reached. The *slipping chronic* exhibits a gradual and often slow retrogression in general condition with extension of the local disease.

The point illustrated here is the high mortality among those who come into the group of slipping chronics. Although this group included some patients whom we were well aware at the time would have been thought by others to be unsuited for surgical treatment, 13 out of 19 survived beyond the period covered by early mortality; and 8 of these are still alive—between one and five years after operation. Recently we have been using more operative stages for such patients, undertaking at each stage a much more limited rib resection and mobilisation; in this way we hope that it may be possible to improve the operative prospects for a group of patients who otherwise are well known to carry an almost invariably fatal prognosis within a short time of entering the category.

A feature of Table III is the similarity of the later mortality to the early mortality in each of the three groups. The total risk for the relapsing chronic is about double that for the stationary chronic—but only about a third of that for the slipping chronic.

Table IV shows the influence of the length of the disease upon both early and later mortalities.

TABLE IV.—LENGTH OF DISEASE IN RELATION TO MORTALITY

Length of Disease.	*Total Cases.*	*Early Mortality.*	*Later Mortality.*
Less than one year	25	0	2
Between one and two years	26	1	2
More than two years	69	11	10

The cases are grouped into three categories: those operated on within a year of onset of disease; those where the disease was between one and two

years duration; and those more than two years from the onset. The most striking feature is the low early mortality experienced in patients operated on within two years of the onset of disease; one, only, out of 51 such patients died whilst in hospital; whereas 11 died out of 69 whose disease was more than two years old.

It is sometimes held that at least two years should elapse from the onset of disease before thoracoplasty is contemplated. Our experience lends no support to this view; in fact, our figures suggest an opposite claim. We believe this is due to the fact that, in general, more extensive disease is found in those of longer duration (Table V), and mortality appears to have a direct relationship to the extent of disease (*vide* Tables VI and VII). It is also our experience that many cases with long-standing disease often prove extremely bad risks although the pulmonary condition appears eminently suitable for thoracoplasty. In assessing suitability for thoracoplasty, therefore, stress is laid far more upon the type, extent, and course of the disease than upon its age.

Table V records the bearing which the length of history has upon the extent of disease. On the operated side the lesions are divided into three groups according to whether one, two or three zones were involved. On the opposite side the groups record patients with no disease, minimal disease (slight infiltration in one zone only and without cavitation), and moderate infiltration or cavitation.

TABLE V.—EFFECT OF THE LENGTH OF DISEASE UPON ITS EXTENT

Length of History.	*Total.*	*Extent of Disease on Operated Side.*			*Extent of Disease on Non-Operated Side.*		
		One-third of Lung Involved.	*Two-thirds of Lung Involved.*	*Total Involvement of Lung.*	*No disease.*	*Minimal Infiltration without Cavitation.*	*Cavitation or Moderate Infiltration.*
Less than one year	25	7	5	13	11	10	4
Between one and two years ..	26	2	9	15	5	11	10
Between two and four years ..	29	0	12	17	6	6	17
More than four years	40	1	14	25	5	16	19

The important feature of this table is the progressive increase in the extent of disease in both lungs with the passage of time. Of 25 cases with symptoms of less than a year, as many as 7 had one-third of the lung or less involved; of the remaining 95 with disease of more than a year's standing in 3 only was the disease of like extent. As regards the opposite lung the figures are equally striking: 21 out of 25 cases in the first group had either minimal or no disease compared with 49 of the remaining 95 patients.

This gradual increase in the extent of disease is to be expected from our knowledge of the life history of tuberculosis. In conjunction with the succeeding tables (VI, VII and VIII), recording the effect of the extent of disease on mortality, it provides a substantial argument in favour of the earliest

possible operative treatment for those patients for whom other methods are inapplicable or have failed to achieve a successful result.

Tables VI and VII record the influence on mortality of the extent of disease on the operated side in the presence of minimal and moderate disease respectively on the opposite side.

TABLE VI.—CONDITION OF IPSILATERAL LUNG IN RELATION TO MORTALITY WITH MINIMAL OR NO INVOLVEMENT OF OPPOSITE LUNG

	Total Cases.	*Early Mortality.*	*Later Mortality.*	*Total Mortality.*
Two-thirds or less of lung involved	30	—	—	—
Total involvement	39	3	5	8

TABLE VII.—CONDITION OF IPSILATERAL LUNG IN RELATION TO MORTALITY WITH MODERATE DISEASE ON OPPOSITE SIDE

	Total Cases.	*Early Mortality.*	*Later Mortality.*	*Total Mortality.*
Two-thirds or less of lung involved ..	28	4	1	5
Total involvement	23	5	8	13

The point which these tables make is the direct relationship between mortality and the extent of disease in either lung. Of a group of 30 patients with less than two-thirds of one side affected and minimal disease or nothing on the opposite side, all were living at the time of review; whereas of 23 patients with total involvement on one side and moderate disease on the other, 13 died during a similar period.

Table VIII deals with disease in the contralateral lung and its relationship to mortality, spread of disease and spontaneous pneumothorax.

TABLE VIII.—CONDITION OF CONTRALATERAL LUNG IN RELATION TO EARLY MORTALITY, SPREAD OF DISEASE AND SPONTANEOUS PNEUMOTHORAX

	Total Cases.	*Early Mortality.*	*Spread of Disease in Non-Operated Side.*	*Spontaneous Pneumothorax.*
Minimal or no disease	69	3	3	—
Moderate disease without pneumothorax ..	39	7	8	—
Moderate disease with pneumothorax ..	12	2	1	4

Coryllos (1936) first advocated the use of a pneumothorax in the prevention of contralateral post-operative spread of disease. The figures quoted here, though small, tend to support this theory. However, 4 out of 12 patients in this group developed a spontaneous pneumothorax, a complication which can be, in this type of case, severe and recurrent and one which might readily weigh the scales against recovery. The indications for a contralateral artificial pneumothorax should, therefore, be carefully considered and the induction not undertaken lightly; once induced, as long as possible—six months if necessary—should elapse before thoracoplasty is commenced to

permit readjustments and compensation to take place. Special care is required during the operative and post-operative periods.

Table IX shows the effect of operation on the cavity, assessed at the time of review, varying from one to nine years after the operation.

TABLE IX.—LATER EFFECT OF OPERATION ON CAVITY

	Total Cases Operated upon.	*Total Cases Followed up.*	*Cavity Closed.*	*Cavity not Closed.*
Lateral thoracoplasty ..	20	10	7	3
Semb	72	54	41	13
Modified Semb	28	25	25	—

In determining cavity closure too much stress cannot be laid on the employment of suitable radiographs. Films of ordinary penetration are of little value in this respect after thoracoplasty; it is essential to use greater penetration and subject all doubtful cases to tomography.

The numbers, though small, lend further support to the contention that apical mobilisation with thoracoplasty increases the prospect of cavity closure. The Modified Semb operation has been the most successful method employed. We believe its success depends on more efficient relaxation of the cavity and its draining bronchi than can be achieved with the standard Semb operation.

Table X records the commoner post-operative complications in relation to the three operations.

TABLE X.—COMMONER POST-OPERATIVE COMPLICATIONS

Operation.	*Total Cases.*	*Ipsilateral Spread.*	*Contralateral Spread.*	*Atelectasis.*	*Wound Infection.*
Lateral thoracoplasty ..	20	2	1	1	5
Semb	72	4	9	15	9
Modified Semb ..	28	5	0	5	5

Although spread of disease in either lung and wound infections are not appreciably affected by the type of operation, atelectasis appears more frequently when apical mobilisation is employed. The more extensive relaxation achieved by the Modified Semb operation does not appear to have increased the incidence of post-operative atelectasis.

One instance each of hæmorrhage and of infection in the extrafascial space were present in this series.

Table XI records the subsequent course of patients with cavities open and closed respectively at the time of discharge from hospital.

TABLE XI.—LATER MORTALITY IN RELATION TO STATE OF CAVITY AFTER OPERATION

	Total Cases Traced.	*Died after leaving Hospital.*	*Cavity Closed at Time of Review.*	*Cavity Open at Time of Review.*
Cavity closed after operation	51	1	47	3
Cavity not closed or evidence inconclusive	45	11	22	12

These figures leave no doubt of the high mortality amongst those who fail to secure closure of their cavities. It is the usual experience for a cavity to be no longer demonstrable within two or three weeks of the final stage of the operation; on the other hand, a cavity which is still present three or four months after the conclusion of the operation rarely closes with the passage of time. It is our practice, therefore, to submit such cases to further operation without undue delay; for it is only by such measures that a high death rate among them can be avoided. The large number of cases in the second group exhibiting closed cavities at the time of review is largely due to lack of satisfactory and conclusive radiographs amongst the earlier patients in the series.

Table XII deals with the early effect of operation on the presence of tubercle bacilli in the sputum and Table XIII with the later effect at the time of review.

TABLE XII.—EARLY EFFECT OF OPERATION ON SPUTUM

	Total Cases Reviewed.	*Sputum Positive before Operation.*	*Sputum Negative after Operation.*
Lateral thoracoplasty	17	16	13
Semb	64	59	46
Modified Semb	27	26	22

TABLE XIII.—LATE EFFECT OF OPERATION ON SPUTUM

	Total Cases.	*Total Cases Followed Up.*	*Sputum Positive.*	*Sputum Negative.*
Lateral thoracoplasty	20	9	2	7
Semb	72	50	5	45
Modified Semb	28	25	4	21

The figures are, of course, affected by the presence of contralateral disease, and to this extent are misleading. Thus 7 out of 11 patients with a positive sputum at the time of review had demonstrable cavities on the opposite side. It should be remembered also that as time goes by patients reviewed form a progressively selected group, since those with a persistent cavity (*vide* Table XI) or a positive sputum exhibit a higher mortality than the remainder. Those reviewed are thus recruited disproportionately from the group with closed cavities and negative sputum. All figures relating to the effect of operation on the sputum should be regarded in this light.

At the time of review many of the patients in this series were still undergoing the process of rehabilitation and had not returned to their previous or some more suitable occupation; we considered, therefore, that a survey of the capacity for work at that time would be misleading. In order to overcome this deficiency the patients were circularised in December 1942, and asked to report on their general health and capacity for work. This latest review was carried out at periods varying from twenty-seven months to ten years after the completion of the operation.

Tables XIV and XV record the general state of health and capacity for work respectively in 58 patients who replied to a questionnaire issued in December 1942. Two patients (one lateral and one Semb thoracoplasty) had died since the earlier survey; one had died from cerebrospinal meningitis, whilst the cause of death in the other was not recorded. Twenty-five patients surveyed earlier failed to reply, and war-time difficulties have not enabled us to trace them.

TABLE XIV.—GENERAL HEALTH OF PATIENTS TRACED IN DECEMBER 1942

Operation.	*Total Replies.*	*Very Well.*	*Fairly Well.*	*Poor.*	*Died.*
Lateral thoracoplasty	9	7	1	—	1
Semb	39	32	4	2	1
Modified Semb	10	8	2	—	—

TABLE XV.—CAPACITY FOR WORK AMONGST PATIENTS TRACED IN DECEMBER 1942

Operation.	*Total Replies.*	*Working Full Time.*	*Working Part Time.*	*Not Working.*
Lateral thoracoplasty	9	5	3	—
Semb	39	24	7	7
Modified Semb	10	5	1	4

Of the 58 patients traced, 47 stated that they were feeling very well, whilst 45 of these were working either full or part time, in most cases in their previous occupation.

Summary and Conclusions

120 patients on whom a lateral, Semb or Modified Semb thoracoplasty was performed between the years 1933 and 1940 are reported. The mortality in relation to the year of operation, course of disease, length of disease and extent of the disease is recorded. The effects of operation on the cavity and sputum are also given.

The mortality rates have been materially reduced as increased experience has been gained in selecting cases and in operative technique.

A division of cases into stationary, relapsing and slipping chronic groups is a useful guide to suitability for operation.

More extensive operations employing mobilisation increase the prospects of cavity closure and sputum conversion, but they do not increase the mortality or the risk of complications.

We wish to thank Mrs. Critchell and associated Lady Almoners of the Brompton Hospital for their untiring assistance in tracing the patients; and, also, Dr. Clifford Hoyle for his invaluable advice in reporting them.

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THE TREATMENT OF TUBERCULOUS EMPYEMA[1]

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Tuberculous empyema is fraught with difficulties for those who have to treat it. Always an anxious event, it happens also to be one whose care is governed by many factors which are often not as assessable as we might wish when decisions upon treatment have to be taken. Though we may be well aware how much a more accurate knowledge would affect the issue, to wait then until time and events make the picture clear often runs a risk that the right moment for intervention slips by. I do not propose here to discuss details of management, and I have no figures prepared from my own cases that might add anything of value to discussion in the way of supporting this or that contention. I intend, rather, to try to give my comments upon how certain general principles, with which we are all familiar, should be employed in these patients, and the emphasis which they should receive in particular circumstances.

We ought to include a word upon the preventive treatment of tuberculous empyema, especially as it occurs during artificial pneumothorax. Its incidence is highest among those who have a pneumothorax limited by adhesions which are preventing healing of lesions in the underlying lung, or among those whose pulmonary disease takes a widespread and caseating form. Both factors are so potent in leading to a complicating empyema that this risk alone should be considered a major reason for stopping a pneumothorax with such features, unless, in the first case, the collapse can be made satisfactory. Too often a delayed empyema comes after months, or even years, of treatment by a pneumothorax which all along has been unsatisfactory. The incidence of empyema in a free pneumothorax is not more than a fraction of its reputed frequency among cases not selected in this way. One can put the matter another way by saying that the risk of empyema as a complication of adhesion section for such patients is far less in skilled hands than the risk run from this source if adhesions are left untouched.

In considering established empyema, a primary consideration ruling treatment is the presence or not of secondary pyogenic infection in the pleura. When it is present aspiration is rarely, if ever, a profitable course except as a temporary or emergency measure. It fails to keep the pleural space empty, rarely controls toxæmia for long, even when supplemented by irrigation with antiseptics, including sulphonamides, and runs a considerable risk of infecting the chest wall. The right line is to secure proper surgical drainage at the earliest possible moment. But drainage, though essential, is but a first step; for rarely is it either desirable, safe or possible to get the collateral re-expansion of the lung which is so indispensable to the cure of this form no less than of

[1] This paper and the two following by Dr. Fowler and Mr. Brock were given at a meeting of the Tuberculosis Association on November 20, 1942, in opening a discussion on "The Treatment of Tuberculous Pyothorax."

ordinary empyema. As a rule, the empyema space is large, the pleura greatly thickened and the lung underneath firmly bound down; so that, however effective drainage may be, the space persists, the bronchial fistula, almost always present, fails to heal, and infection drags on with its inevitable sequels. When the state of the other lung or of the chest wall prevents any other moves within a short time, or when drainage does not improve the general condition sufficiently to allow a later thoracoplasty, the outlook is most grave. Few, if any, of these patients recover; but as it is far from easy, at the time a need for drainage arises, always to be sure that these factors prohibit any prospect of eventual improvement, and as, in any case, it serves a palliative purpose, drainage should not be withheld.

For all others—that is, those in whom the state of the other lung, the chest wall and the general condition permit—drainage needs to be followed within a short time by thoracoplasty, staged with a careful eye upon a patient far from an easy risk. It performs essential services: obliterating the pleural space, preventing excessive loss of protein when the discharge is copious, and maintaining a satisfactory collapse of the lung. Indirectly, it also helps to close the bronchial fistula. When the original pneumothorax is still contraselective or when there is a bronchial fistula of any size, the urgency for thoracoplasty is all the greater in that spontaneous risk of further disease in the sound lung is serious, and is not improved by waiting at this point. The objections raised to thoracoplasty are chiefly that it is a big ordeal for a very ill patient, that there may be additional amyloid disease, and that it does not always close the empyema space or leave the patient free from sinuses. But we are dealing here with a condition which has an ultimate mortality approaching 100 per cent. if the pleural space is not effectively reduced; the combined mortality from thoracoplasty in suitably chosen cases plus that from subsequent disease in those so treated is nothing like as high as this. Amyloid disease is an indication for thoracoplasty rather than otherwise, unless far advanced.

Although there is pretty general agreement on the lines which treatment ought to take for a secondarily infected tuberculous empyema, this is not so for the simple forms. We are all aware of the need for aspirations to remove the pus, air replacement to adjust the pleural pressures, and often also of pleural lavage to remove flakes or plaques of fibrin. For a majority these comprise the best immediate policy. But there are some examples, coming without evident warning and continuing without affecting the general situation of the patient in any obvious way, in whom a slow acquisition of the pus is gradually halted even if it is left alone. We know other examples of the capacity of the pleura for restricting and eventually overcoming infection; ordinary serous infections are a striking instance, for it is rare for them to go astray. We know, too, that the mere presence of tubercle bacilli in the pleura is not enough to cause a progressive pyothorax of necessity. It would be surprising if, among tuberculous empyemas, there was no group in which the power of the pleura to deal with the infection was not adequate; and such cases are on record. Chandler gave a few recently which he had followed for many years, but he recorded them as selected instances, generalising, as I read him, in a way intended to apply only to this limited group of cases.

The difficulty with this small group of cases is to decide in the initial stages that a course so favourable is likely to be the outcome for any individual subject. I do not know how such a forecast may be made. A second difficulty that arises in patients so treated is the ultimate compulsion which the policy entails of a non-functioning lung, however fortunate the course in other ways, and even where re-expansion might reasonably be allowed. The mechanical disability imposed by an arrested and often inspissated collection of pleural pus may then be a permanent and unwarranted handicap. This objection does not hold when the disease in the underlying lung requires permanent rather than temporary collapse; for an obsolete pyothorax may provide such collapse, especially as the fluid collection often becomes displaced upwards slowly, so controlling the upper part of the lung, commonly the main seat of disease. It is not the presence of pus which matters then so much as the stability of the original disease in the pleura, and the corollary of this, the absence of risk from increasing tension in the collection, which is, in any case, walled in by an almost armoured pleura.

I have deliberately dealt with these favourable examples of pyothorax because their treatment is, more than any other, a matter upon which opinion is divided. The existence of a few patients in whom inactivity pays is undeniable: the real difficulty is to select them, and, at present, this seems to me to be an insuperable objection to such treatment unless we are to court the risks of frequent failure.

Turning now to the great majority with progressive disease in the pleura, the first point to make here is that the immediate results of frequent aspirations of the pus with adjustments of the intrapleural pressures by air replacements are commonly good. Whether lavage does anything more than ease the technical problem and clean the pleural surface I am very doubtful. There is nothing in the pharmacology of the many antiseptics which have been used for lavage to suggest that any of them can control the tuberculous process; and, even if they could, it is difficult to see how such an action could be brought to bear upon the depths of the pleura, where it is wanted, merely by surface lavage. But aspiration, with or without lavage, nevertheless is an effective measure for the control of toxæmia and for assisting re-expansion of the lung. Only indirectly in this way does it affect the ultimate outcome; for this depends on other things—much, of course, upon that incalculable thing, the capacity of the individual to deal with the disease, and much upon whether healing of the empyema cavity can be secured by firm union between the pleural layers. Otherwise, surface caseation is liable to go on, pus steadily forms, burrowing into the chest wall or into a bronchus, and eventually becoming secondarily infected.

General measures, proper rest and repeated lavage and aspirations will sometimes succeed in converting a progressive empyema into a non-progressive one; and if this happens, and is steadily maintained, and at the same time the control of the underlying lung is satisfactory, then I see no valid reason why it should not be regarded as the right policy. But if within a reasonable time, measured in months, it becomes clear that the pleural disease is not amenable to such treatment, then for most cases the only circumstance in which it will become arrested is when the pleural space no longer exists. In other words,

this is the indication for aiming at obliteration of the empyema cavity, for I am not impressed by the record of oleothorax for such patients. My own experience of this has been limited, so I prefer to leave to others a fuller discussion of its value.

The easy way of obliterating the empyema space is by re-expansion of the underlying lung. It is clear enough that in trying to solve the pleural problem in this way we face frequent and serious obstacles. The lung may be bound down as in secondarily infected cases, and no amount of lavage will improve its expansibility. Or it may be obvious that the lung is in no condition to permit re-expansion without at the same time incurring risk of fresh activity of the disease within it, or of reopening cavities. But there are cases for which a policy of re-expansion is suitable and is often attainable; those where a pyothorax is accompanied by little or no evidence of disease in the underlying lung, or in whom such disease is already old-standing and has been long and effectively treated by pneumothorax. Such cases are exceptional, and there is, moreover, the difficulty of judging the extent, the character and the stability to re-expansion of the pulmonary lesions when the lung is collapsed. We may be helped to a decision by the absence of focal pulmonary symptoms, cough and hæmoptysis, by the consistent absence of sputum or the presence of not more than traces always free from tubercle bacilli, and also by the absence of cavitation as revealed by penetrative films and tomographs. If the conditions upon which re-expansion may be safely allowed are fulfilled, then it should be the aim of further treatment for long enough to complete the process or to judge its probable failure. Such a policy of active re-expansion of the lung needs constant review. If at any time during its conduct the safety of the patient's position can be called into question, then further re-expansion should be stopped. For at that point we have to balance the profit to the pleural infection by obliterating the empyema space in this way against the loss to the patient from the risks to a lung no longer relaxed as it ought to be. Once it is evident that re-expansion will not be adequate to close the space or will be harmful to the underlying lung, then it should be abandoned.

It comes to this: where there is a persistently active pleural infection thoracoplasty, modified to suit the circumstances, is essential for those in whom re-expansion of the lung is neither feasible nor desirable. For it is then the sole means by which the empyema space can be closed effectively. Some re-expansion of the lung, even then, is a technical help to thoracoplasty in deleting the space, and should be a preliminary, providing that it can be achieved without harming the lung. Pleural aspirations between stages are wanted if the maximum collapse of the chest wall is to be secured; and the application of weights also helps. The benefit from thoracoplasty is often immediate since the formation of pus dwindles to a trickle.

Though the operative dangers are still far from negligible, taking a broad group of favourable with unfavourable cases, for many the risk of modern thoracoplasty is small. The firm chest wall and mediastinum in these patients greatly reduces the risk of paradoxical movement, and the rapid benefit conferred by an initial stage of removal of seven ribs without mobilisation can be striking.

The limits set to the advisability of thoracoplasty are those conditioned by

the state of the other lung and of the chest wall, and by the general feasibility of operation in the individual. But the decision here, in the class of patient under review, is much more than one of choosing the preferable course out of a number of possibilities. It is, in popular terms, a strategical decision, for it decides the outcome of the entire campaign of treatment. The alternative risks, without thoracoplasty, are so high that it seems to me fair to take a less restricted view of those admissible for operation than would be done in the absence of pyothorax. I think this view is also justified on technical grounds, for the dangers of aspirating secretions into the other lung are reduced when the lung on the operated side is already relaxed and fixed as it is in pyothorax cases; and there is freedom, too, from post-operative collapse of the base of the lung on that side, when that base is already controlled. In other words, the operative prognosis in pyothorax cases is better than in those whose thoracoplasty is done for uncomplicated phthisis of similar type and extent. I am not sure that figures have yet given substance to this view, but perhaps surgical colleagues can enlighten us from their own experience or from the literature.

In choosing those for thoracoplasty the general condition is of far less importance as a source of risk than the condition of the contralateral lung and of the chest wall. In the first place the general condition is deceptive, because the relief from toxæmia after thoracoplasty is often so rapid that it more than counters the operative disturbance. Then, again, these patients can be improved beforehand, where required, by blood transfusion, and also during actual operation. Another factor in the general survey, the cardiovascular risk, is often overestimated. With very few exceptions tuberculous patients do not die from intrinsic myocardial damage, whether they have a thoracoplasty or not. They retain normal rhythm, have a normal circulation time, and hardly ever do they present the features of left or right heart failure. Tachycardia and a moderate reduction of blood pressure are not expressions in them of myocardial disease, but of toxæmic interference with the extrinsic nervous control of heart rate and vasomotor activity. As such they are not evidence of a cardiac risk and should not be given weight in a decision against operation. But when there is independent myocardial disease, commonly atheromatous in middle life, the cardiac factor needs close and careful scrutiny as a major source of danger for those requiring operation.

THE TREATMENT OF TUBERCULOUS EMPYEMA

By WILLIAM C. FOWLER.
From Pinewood Sanatorium.

The rational treatment of tuberculous empyema demands some sort of understanding of the factors which determine the onset and natural course of the disease.

If tuberculous empyema is regarded as a purulent effusion between the layers of the pleura, we may possibly regard every case of thickened adherent

pleura in a tuberculous subject as having had an aborted empyema. It means that a cellular reaction has occurred as a result of pleural infection either of hæmatogenous origin or by spread from underlying diseased lung or along lymphatic channels. Whether or not an empyema forms depends on the virulence of the infection and the resistance of the host. Why do some of these effusions remain clear and others become purulent, especially as comparatively clear effusions may contain many tubercle bacilli and purulent effusions may occasionally appear to be sterile or contain very few organisms?

There is, of course, no sharp line of demarcation between a tuberculous pleurisy and a tuberculous empyema. The former may gradually change into the latter without any constitutional effect on the patient. On the other hand, the pleurisy may be accompanied by violent febrile reaction and within a few days or weeks the effusion becomes purulent. The striking thing is that the fluid is much more likely to be purulent if air is also present than if it is absent from the pleural cavity. Why is this? There are several factors to be considered. In the case of spontaneous rupture of the lung cavity into the pleura in the course of artificial pneumothorax treatment the explanation may be that the pleura suddenly becomes deluged with a large dose of tubercle bacilli. The unsupported walls of a cavity are more ready to rupture suddenly if an artificial pneumothorax has been induced than if the pleural membranes are in close apposition even if they are not wholly adherent. A cavity whose walls are not only unsupported but are perilously dragged upon by a cord-like adhesion may be ruptured by any excessive movement and its contents emptied into the pleural space. Some have endeavoured to explain all or almost all tuberculous effusions in artificial pneumothorax cases, clear or purulent, by the rupture of a tuberculous patch or cavity. Certainly their abrupt and often unexpected onset gives credence to this idea, and the intra-pleural pressures taken shortly after onset may give some confirmation of this.

In the course of treatment with artificial pneumothorax I find that those effusions with a severe pyrexial onset are much more likely to become purulent than those with an insidious onset, which are presumably of hæmatogenous origin, or those accompanied by X-ray changes in the appearance of the collapsed lung, which suggest a simple extension of infiltration on to the surface of the pleura. Purulent effusions in the chest are much more common now that artificial pneumothorax is used so freely, and we are, in fact, now discussing a complication which is often directly or indirectly caused by our interference with the pleural space.

Whatever the precipitating cause of the empyema, the fact remains that if air and fluid are present together the fluid is much more likely to become purulent than in a pleural effusion where air is absent. It may be said that secondary infection accounts for this, either coming from the contents of the ruptured cavity or introduced from without by the operation of para-centesis.

Recent bacteriological investigation of the contents of cavities explored by direct puncture in the course of Monaldi suction drainage shows rather surprisingly that cavities are not usually cesspools of secondary infection, as used to be supposed. They are often free from any organisms except tubercle bacilli until several days after drainage has been established, when secondary

infection enters along the line of puncture. Furthermore, effusions in pneumothorax spaces are frequently purulent, but rarely show evidence of secondary infection unless a sinus has formed in the skin along a needle track through which infection from the skin has travelled.

We venture to suggest, therefore, that the presence of oxygen in the form of intrapleural air is an important factor in causing tuberculous effusions to become purulent instead of remaining serous. In support of this are the following observations:

1. Purulent effusions are much more common in artificial pneumothorax exudates than in ordinary pleural exudates without pneumothorax.

2. Tubercle bacilli are shown to be markedly aerobic—in fact, in artificial culture they may be said to be almost obligatory rather than facultative aerobes: growth occurs only on or close to the surface of the medium.

Dr. Stanley Griffith in the Medical Research Council's System of Bacteriology quotes Novy and Soule, who state that to obtain a rich growth on a single tube of glycerin agar 100-150 c.c. of oxygen, corresponding to 500-700 c.c. of ordinary air, must be provided. The optimum oxygen pressure is between 40 and 50 per cent.

Boyd ("Pathology," 1938, p. 146) states that "local physico-chemical conditions must play an important part in determining the localities of infection. When an animal is injected with tubercle bacilli, innumerable lesions will be found in the lungs, but only minimal infection in the liver. The tubercle bacillus, which is highly aerobic, does not flourish in a low oxygen tension, and as the lung has the highest oxygen tension, and the liver a low oxygen and high CO_2 tension, the distribution of the lesions is readily understood."

Fairbrother ("Bacteriology," 1941, Chapter XXIII) says that "aerobic conditions and moisture are essential for growth, which is absent or very slight in the absence of free oxygen."

The treatment of tuberculous pyopneumothorax is best accomplished by obliterating the space in which air may remain. If the pus and air are withdrawn and the two layers of pleura brought together by some means or other the formation of pus tends to cease. In this way the bacilli are forced to live in a medium with relatively low oxygen tension instead of on a large surface of pleura in an atmosphere containing about 16 per cent. of oxygen. This suggestion possibly explains the favourable action of oleothorax in which the sealing of the fluid from oxygen may be an even more potent factor than any antiseptic qualities the oil may have in preventing the growth of tubercle bacilli. It may also reduce the oxygen available on the surface of the pleura above the level of the pus and delay the multiplication of bacilli.

Treatment, therefore, must aim not only at removing the pus before it develops a positive pressure or becomes too thick, but at obliterating the air space above it, either by re-expansion of the lung, if that is not contra-indicated, or by thoracoplasty, or by both these means.

Where there is a broncho-pleural fistula it may take months of regular pleural lavage before the lung rupture heals or before a thoracoplasty is at all safe.

As in all medical or surgical procedures, the important thing is for the

doctor to plan a long-term policy for the patient, so that nothing that he does today will interfere with any other line of attack should the simpler measures fail. Pleural effusions are often needled light-heartedly in such a way that (1) the pleura is left half full of debris that will not go through the needle; (2) a sinus results, which allows secondary infection to enter with disastrous results; or (3), if this disaster does not occur, the sinus is in such a position that it interferes with a proper thoracoplasty.

Every case of tuberculous empyema should be treated from the start with the idea that it might need a thoracoplasty sooner or later. Hence needling for diagnostic purposes should be made with great care well away from the field of a possible thoracoplasty operation. If pus is found, any subsequent punctures for lavage should be made high up in front of the chest well above the level of the fluid. A thoracoscope trocar and cannula should be used so that a rubber catheter can be introduced or a Roberts suction tube passed through the cannula down to the bottom of the pleural space. In this way masses of debris can be sucked up, which would never pass through an ordinary needle or trocar, and at the end of the operation a thoracoscope can be passed in and an inspection of the whole pleural space made to look for pocketing or for fibrinous masses, which can be disintegrated by the powerful suction on the Roberts tube.

Fluids such as Dakin's solution to soften the debris may be left in the pleural space without the possibility of seeping into the subcutaneous tissues through the trocar puncture. Above all, this puncture, made high up in the air space, is not expected to heal up in a bath of residual tuberculous pus, as is the case with the usual puncture made at the lowest available point of the empyema.

One other advantage of the method is that the procedure is done with the patient comfortably propped up in a semi-sitting posture instead of the awkward tilting positions necessitated by a low axillary or posterior approach. Properly carried out with a local anæsthetic, the introduction of a thoracoscope trocar and Roberts tube or a catheter is comparatively painless and much safer than plunging about with a needle or trocar below the level of the pus, with the possibility of having to make two or more shots before the pus is reached and leaving a track or tracks bathed in pus.

All the above procedures will not cure the empyema unless the lung re-expands or the pleural space is obliterated by surgical measures. If the lung does re-expand the excavation the pneumothorax was designed to close will in all probability remain open or reopen. In any case, washing out should not be carried on in the vain hope of a selective re-expansion if the pleura is thickening up so much as to make a thoracoplasty ineffective or unduly difficult.

It is not my province to deal in detail with the surgical procedures, except to add that shortly before the operation the empyema must be drained as dry as possible, and no surgeon should be asked to operate unless there is an efficient suction apparatus handy in case the pleura (which is often very friable) is opened. A portable X-ray apparatus is a great asset for detecting the formation of appreciable amounts of pus during the time when it is undesirable to move the patient to the X-ray room. If there is a sinus along

which a catheter can be kept in position without air leakage, then low-pressure continuous suction should be started as soon as possible after the operation by means of a water pump or an aquarium pump with a suitable adjusting valve. One patient so treated at Pinewood made an excellent recovery. The drainage tube in this case was of lead, and could be moulded comfortably to the curve of the sinus track.

While attention is naturally focused on the pyothorax, the condition of the other lung should be carefully watched, having in view the fact that a thoracoplasty may be needed sooner or later. A cavity or infiltration may need an artificial pneumothorax, and this may well be done early in the treatment, so that by the time conditions are ripe for thoracoplasty this contralateral lung may not be a bar to its safe accomplishment. In some cases without a cavity a course of sanocrysin may be beneficial.

THE TREATMENT OF TUBERCULOUS EMPYEMA

By R. C. BROCK.
From Guy's Hospital and the Brompton Hospital.

The object of this paper is to show—

1. That tuberculous empyema is a serious condition which must be treated with respect.
2. That treatment must be prompt and vigorous; that conservatism fails in most cases.

These two premises will be justified by a study of my own series, which consists of 90 cases of uncontaminated tuberculous empyema and 84 cases of tuberculous empyema contaminated by secondary infection. These do not include all the cases I have seen, but only those of which I have kept notes. There have been a certain number more whose condition was hopeless when seen and of whom I have made no record; these would, if anything, tend to make the picture even gloomier.

The summary of my own views based on my actual experiences in this series of cases is:

1. (*a*) Tuberculous empyema is a serious condition with a high morbidity and mortality. (*b*) Secondarily infected tuberculous empyema is even worse.

In fact, together these two constitute one of the common modes of termination of pulmonary tuberculosis.

2. (*a*) The best results are obtained by securing pleural obliteration, and if this can be safely achieved by expansion of the lung, so much the better. By all means give a short trial of aspiration and pleural lavage if thought desirable, always remembering that if the lung still contains active, uncontrolled disease a thoracoplasty will be needed in any case.

(*b*) In any event *the pneumothorax should be abandoned.* The risk of maintaining it is just not worth while taking for the few that may dry up and

continue safely with a good pneumothorax. The position is not unlike that seen in acute appendicitis in which we know that conservatism will result in a number of cases resolving spontaneously, but the selection of such cases is almost impossible clinically, and attempts to make the selection will bring death or grave illness to many who would have made a speedy and safe recovery with operation. Artificial pneumothorax is not a treatment for pleural tuberculosis; in fact, it is a bad and dangerous treatment. By recognising this and abandoning the pneumothorax promptly, much trouble and disaster will be prevented. As a corollary of this one cannot condemn too vigorously the still too prevalent practice of persisting in an ineffective and contra-selective pneumothorax even in the absence of pleural infection. This practice is responsible for many cases of tuberculous empyema which could have been entirely prevented if the pneumothorax had been abandoned as soon as it was recognised that it could not be made effective. The percentage incidence of purulent effusions in every series of pneumothorax cases is high, far higher than the incidence of such effusions after cauterisation of adhesions (Brock, 1938). In other words, one of the best treatments for tuberculous empyema is *not to let it occur.*

(*c*) Thoracoplasty is needed in most cases of tuberculous empyema; especially so in view of the usual condition of the underlying lung.

3. The appreciation of the need for, and the carrying out of, correct treatment must be prompt.

Tuberculous Empyema.

There are many aspects of this problem which need discussion, but I am going to discuss more particularly the question whether it is correct to ignore a tuberculous collection of pus in the pleura by treating it very conservatively, or whether it must be taken seriously and dealt with accordingly.

I hold that one of the basic and cardinal beliefs of a surgeon should be that wherever there is pus it should be evacuated; that whenever we depart from this truth, even though supported by learned and philosophical argument, we are laying up trouble for ourselves and for our patients. Tuberculous pus is no exception to this general rule, and I cannot bring myself to accept that it is safe or desirable to allow a patient to walk round, or even rest in bed, with a collection of tuberculous pus in his chest. It is true that some patients seem to suffer but little harm, but so do some cases of appendicitis. For the greater number, however, these conditions are liable to be followed by disaster.

For this reason I wish to consider the short paper by the late Dr. F. G. Chandler in which he advocated the conservative treatment of tuberculous empyema. I feel that this advocacy of conservatism coming from such an authoritative source is bound to carry such a weight that it should not pass unchallenged. One naturally hesitates to criticise the published work of one who has so recently left us, and of one who was such a gifted, careful and experienced physician; but I think I knew Dr. Chandler well enough to feel sure that he himself would have welcomed an open discussion of his views and problems. He was always most anxious to arrive at the real truth of things, and in this attitude was blessed with the mind of the perpetual student.

In his paper he put forward his experiences in 12 highly selected cases of tuberculous empyema, all of which did very well on conservative treatment, as a basis for argument that these cases should *all* be treated in this way. The following are some of his actual remarks:

(*a*) "My own view, based on long experience, is that they should be left alone unless there is some very definite reason for intervention; that they often do more good than harm; that they can persist for ten or twenty years or more, the patient keeping in perfect health."

(*b*) "The purpose of this communication is to show that fluid, tuberculous empyema and sterile collections of pus, even when large, may be benign, and may be left alone, the patient remaining in perfect health; that none of the above-mentioned disasters will happen; that they are not of necessity pernicious."

I propose to show that my own experiences with these cases make Chandler's observations untenable. I disagree with his statement that these effusions, far from being harmful, often do good; I think the correct thing to say is that they are almost always harmful although very occasionally they may not be so. He makes no mention at all of thoracoplasty except to dismiss it as an unfortunate and unsatisfactory expedient. I hope to show that in it we possess a method of treatment which gives the most satisfactory results.

His paper is supported by 12 cases only, and omits to give any suggestion of what percentage this forms of all the cases seen in his long life of very active work in chest diseases. In my own short experience I am able to present nearly 100 cases, and I imagine that Chandler's 12 patients constitute but a small, but conversely highly selected, percentage of the many hundreds he must have seen. He makes no mention of what is fundamental in considering this problem—namely, the condition of the underlying lung; and indeed reference to his case histories shows that in all of these the lung disease was apparently under control or had always been minimal. The greater number of patients with a tuberculous empyema do have active uncontrolled pulmonary disease, and it is not practical to pass over this basic fact. Although he quotes 12 cases with a benign clinical course, most workers in tuberculosis could quote three or four times this number with a malignant course; and even though some of his cases have continued well for many years, I have had cases come to disaster after as long as ten or even twelve years.

That my experiences are not unique is shown by many published papers, but I will refer to only one of these. Woodruff (1938), writing from Saranac Lake, gives a report on 154 cases of tuberculous empyema, 112 of which were not secondarily infected, 42 of which were contaminated. They were followed up for from three to eight years, and he states that "of those patients who originally had a non-contaminated tuberculous empyema and who did not die of it, 30 per cent. finally developed complications either by perforation or by secondary infection; others may later do so." Of the 154 patients, 64 were known to be dead at the time of the follow-up, a mortality of 42 per cent.; the longer any series is followed the higher is the death-rate.

His findings in regard to treatment were:

(*a*) With aspiration alone: in uncontaminated tuberculous empyema, 40 per cent. of the patients were dead, 40 per cent. well.

(*b*) With aspiration and irrigation with salts and dyes the results were but little better.

(*c*) Oleothorax: of 22 patients exactly one-half did well, and in this it shared first place with those cases in which encouragement of lung expansion caused early pleural obliteration. The mortality rate was, however, high.

(*d*) Thoracoplasty is of great value in both contaminated and uncontaminated tuberculous empyema.

He concludes that all those patients who are apparently well but are carrying round the remains of their empyema or an oleothorax are in almost daily danger of a sudden serious or fatal complication.

My own series of tuberculous empyema cases numbers 90, although I should say that in one way this figure is not strictly genuine as it is swollen by 48 from my series of cases of secondarily infected tuberculous empyema who passed through a preliminary period as a simple tuberculous empyema. I think this inclusion is justifiable, for, although it may be that there has been a high selection of the worst type of case, it does at any rate show one very important, albeit not benign, side of the condition.

Tuberculous empyema	90 cases.
Progressed to secondary infection	60 cases.
Conservative treatment or drainage alone	42
Died	33
Alive	9
(Of these patients 2 are awaiting thoracoplasty, 2 are hopeless, and only 5 are satisfactory.)	
Mortality	77 per cent.
Thoracoplasty	48
Died	7
Alive	41
Mortality	14 per cent.
Total mortality 40/90	44 per cent.

It should be noted that the total mortality of 44 per cent. is not far different from that of Woodruff's series, in which it was 42 per cent.

The 48 cases of thoracoplasty include those patients who progressed to secondary infection. Thoracoplasty was performed on 21 patients in whom the tuberculous empyema was uncontaminated, and of these 21 patients only 1 died, the remaining 20 doing well. Even this patient could be justifiably excluded as a death due to thoracoplasty; she had extensive cavitation and exudative disease of the underlying lung and infiltration of the opposite lung. She went home after the first (three-rib) stage of the thoracoplasty and died some nine months later. In fact, therefore, she did not have her empyema collapsed by thoracoplasty and quite fairly could even be included in the results of conservative treatment.

THORACOPLASTY FOR TUBERCULOUS EMPYEMA

Uncontaminated	21 cases.
Died (thoracoplasty uncompleted)	1
Alive	20
Mortality	5 per cent.

These figures show that a tuberculous empyema cannot be considered as anything but a serious condition; that the results of conservative treatment

are poor; and that unless there is an immediate response to aspiration and lavage the patient should be submitted to thoracoplasty as soon as feasible, for the results of this treatment are superior to all others.

Secondarily Infected Tuberculous Empyema.

No one will deny that this condition is of the utmost gravity and, unless promptly and properly treated, carries a mortality of nearly 100 per cent. In spite of this, we constantly see cases in whom the will-o'-the-wisp of possible spontaneous resolution aided by conservative treatment has been pursued for several months. Perhaps 1 or 2 per cent. of patients will make some sort of recovery, but how we are to select these rare ones I do not know.

The analysis of my own series of 84 cases speaks for itself.

Tuberculous empyema (pyogenic)	84 cases.
Drained only	35
Dead	32
Alive (one awaiting thoracoplasty)	3
Mortality	91 per cent.
Thoracoplasty and drainage	49
Dead	14=29 per cent.
Alive	35=71 per cent.

Of the 14 patients who died after thoracoplasty three survived the various stages of the total operation and were well, but succumbed to over-enthusiastic attempts on my part to close the last part of the cavity by means of a Schede's or a Robert's flap operation. If these three are excluded we have a mortality of only 22·5 per cent. with a survival rate of 77·5 per cent. for thoracoplasty.

Complete healing without a sinus has been achieved in 15 patients.

Healed after thoracoplasty	15 patients.
Of survivors	15/35=43 per cent.
Of thoracoplasties	15/49=30 per cent.
Of all cases	15/84=18 per cent.

Of considerable interest is an analysis of the results from the point of view of the condition of the underlying lung.

Secondarily Infected Tuberculous Empyema

Cases with active disease		62
Thoracoplasty	29	18 alive. 7 healed. 11 dead.
Drainage only	33	31 dead. 2 alive.
Cases with controlled lung disease		9
All had thoracoplasty except one, who is waiting		7 alive. 2 healed. 2 dead.
Pleural disease only		13
One died after drainage; remaining 12 had thoracoplasty		11 alive. 2 dead. 5 healed.

It will be seen from these figures that the prognosis with active lung disease is extremely bad and that the results with thoracoplasty are less good than when

disease in the lung is controlled or absent. It is, of course, often difficult to say that there is no active parenchymatous disease, but of the 13 cases included under pleural tuberculosis only, none had evidence of phthisis at any time. Infection followed external drainage of a cold abscess of the chest wall in two cases. The one death after thoracoplasty in this group in which the disease was totally confined to the pleura occurred in a man of forty-five who had had a huge discharging empyema for seven years.

My own views, based on these experiences, are as follows:

1. In many patients the condition is hopeless, but it is often possible, even in apparently moribund patients, to achieve much by drainage, and some of these will eventually win through. The biggest drawback to recovery is contralateral disease.

2. Whenever even remotely possible, thoracoplasty should be begun within a very short time of drainage, measured in days, not weeks, and certainly not in months.

In this connection I would like to make the following points. It is no good waiting for the temperature to fall to normal before beginning operation. Persistent fever, far from being a contra-indication, is one of the indications for early operation. In many of these cases the temperature will only fall to normal when thoracoplasty has been completed.

Secondly, if the temperature does not fall, or even rises higher after drainage, the physician should not complain to the surgeon that drainage is inadequate or misplaced, neither should the surgeon be intimidated into making new and larger drainage holes. The temperature is part of the pleural infection and will be controlled when the cavity has been collapsed.

To wait month after month in the hope that the patient will improve is wrong. Even in those cases which show some improvement this is offset by the dense pleural thickening and rigidity that makes these late operations hard for both surgeon and patient and militates against the efficacy of the collapse.

3. By performing thoracoplasty after drainage we rid our patients of the risk of amyloid disease or progressive deterioration from septic absorption. In many we have to be content with this, and the patient has to be content with carrying a tube for many years or possibly for ever. After all, he may even be counted as fortunate that he is alive to carry his tube.

By the time a patient has had tuberculosis and has gone through the catastrophe of a tuberculous pyothorax and the successive stages of drainage and thoracoplasty, I think he has had enough for the time being. Most patients agree with this and are content to suffer their drainage tube in patience for a long time. Others, gluttonous for further punishment, or impatient with their fate, become importunate and will request further operation to enable them to lose the tube. My present bias, based on experience, is against being importuned in this way, and my answer is that they must continue to be patient and give Nature plenty of time to do her best in completing the collapse we have begun. Given generous time she will be most generous in her returns. After one, two or even three years we shall find that the cavity, aided very often by constant suction, has contracted down so much that either the tube can be left out and healing follows, or some relatively small and reasonable

procedure will allow final healing to occur. During the last two years I have seen several patients who possessed one of those large flat residual cavities extending from apex to base and from which one shrinks in dismay at the magnitude of the surgical procedure necessary to effect obliteration, and who by waiting have entirely changed. Healing has then followed removal of the tube or a quite simple final local plastic operation.

Conversely, I have allowed myself to be persuaded by the patient on two occasions to operate when I was unwilling; both patients died. I think, however, there comes a time when the request from the patient becomes a reasonable one and when surgery should be able to give them that final complete healing which they and we desire. In those cases further surgery is not only justified but indicated and may give us one of those happiest although most uncommon of patients—one who has completely recovered from this major disaster of a secondarily infected tuberculous empyema.

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THE TRANSPLEURAL DRAINAGE OF TUBERCULOUS CAVITIES

By R. J. C. MAXWELL and M. L. KOHNSTAMM.
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The closed drainage of tuberculous cavities in the lung by introducing a tube through the chest wall and applying suction was first essayed by Eloesser (1937), who abandoned the method after a short trial. Soon afterwards Monaldi (1938) began investigating its therapeutic possibilities, elaborated a technique and popularised the method.

A considerable Continental literature already exists on the subject, and several papers have appeared in English (Cussen, 1941; Davidson, 1941; Dolley, 1940; Goldman *et al.*, 1941; Kupka *et al.*, 1940, 1941; Roche, 1941; Shipman *et al.*, 1941). No attempt will be made to give a complete account of the many aspects of cavity aspiration in the present article. Its purpose is to describe a satisfactory technique, to present in some detail the results in the earlier cases treated, and to record our impressions of the possibilities and limitations after nearly two years' experience.

Monaldi (1938) based the treatment on the conception that while tissue destruction is primarily responsible for the formation of a pulmonary cavity, its further growth and persistence are, in the majority of cases, due less to biological than mechanical factors—namely, thoracic wall traction and cavity inflation by air entrapped distal to an inflamed and partially stenotic bronchus. The creation of a negative pressure inside the cavity eliminates both these

forces, the cavity shrinks and closes, and the space previously occupied by it is filled by re-expansion of atelectatic tissue in the cavity wall and the development of compensatory emphysema in the surrounding lung. At the same time suction removes the necrotic tissue lining the cavity and the accompanying passive hyperæmia overcomes the tuberculous process in the cavity wall; tubercle bacilli disappear from the sputum and secretions; and the walls, as they are lined by healthy granulation tissue, heal readily once they come into apposition. Monaldi (1939) stressed the importance of bronchial closure in obtaining a permanent result, and the post-mortem findings of Pana and Bottari (1939) suggested that cavity drainage tended to produce complete bronchial occlusion by a process of proliferative endobronchitis.

Methods.

Artificial Obliteration of a Free Pleura.—Fusion of the pleura at the site of catheter insertion is essential. The majority of pulmonary cavities are situated in the upper lobe, and the most convenient approach for drainage is through the first or second interspace in front. This is usually the last part of the pleural cavity to obliterate spontaneously. A free space was present here in over two-thirds of our drainage cases, although institution of an effective pneumothorax had failed in all. Obliteration of this potential pocket by the method of Kupka and Wagner (1941) has proved extremely satisfactory. The technique is simple: 5 to 100 c.c. of the patient's own blood are injected intrapleurally and, unless the pocket is very localised, the patient is nursed prone with the foot of the bed raised for twenty-four hours. Any pneumothorax induction needle with a Record syringe fitting may be used. An important point is that, before injecting the blood, as much as possible of the air previously insufflated to assess the size of the pocket should be withdrawn in order to bring the pleural surfaces into close apposition. To prevent loss of time in posturing, the injection should be carried out in bed and on the ward. The pleura is tested again at fortnightly intervals and the procedure repeated if necessary. Once symphysis is established at the site of operation, it is advisable to test for a free space about 2 cm. laterally and medially as well as in the space below and, except when dealing with the first interspace, in the space above. If a free pleura is found at any of these sites, artificial obliteration is carried out there. A very dense localised pleural scar results. There is no febrile reaction and no pain. The method has been employed in seven patients and proved successful in all of them. An average of three injections was required to produce fusion.

Instruments for Catheter Insertion.—The equipment is in part the same as for pneumothorax induction—viz., local anæsthetic syringe and needles, scalpel, pneumothorax apparatus and induction needles. The special instruments (Fig. 1) required are a cavity needle, a trocar and cannula, catheters and rubber flanges with sheaths. The cavity needle is a long No. 17 gauge pneumothorax needle graduated in centimetres. A modification of Bottari's and Babolini's (1939) trocar and cannula, constructed on the same principle as the Kuss pneumothorax induction needle, is used. The graduated barrel of the cannula is 14 cm. long with a lumen 4 mm. in diameter, admitting a No. 6 English catheter. A sliding metal shield can be fixed anywhere on the barrel

to prevent penetration beyond a desired depth. There is a lateral arm near the outer end for connection with a manometer and two side openings near the inner end. The trocar has a broad head with a rather blunt point and a thin shaft of smaller diameter than the cannula lumen, allowing air to communicate freely with the manometer through the side openings of the cannula. For reintroduction of the cannula, to pass a cavernoscope or reinsert a catheter, a light olive-ended obturator is employed. The catheters are of radio-opaque

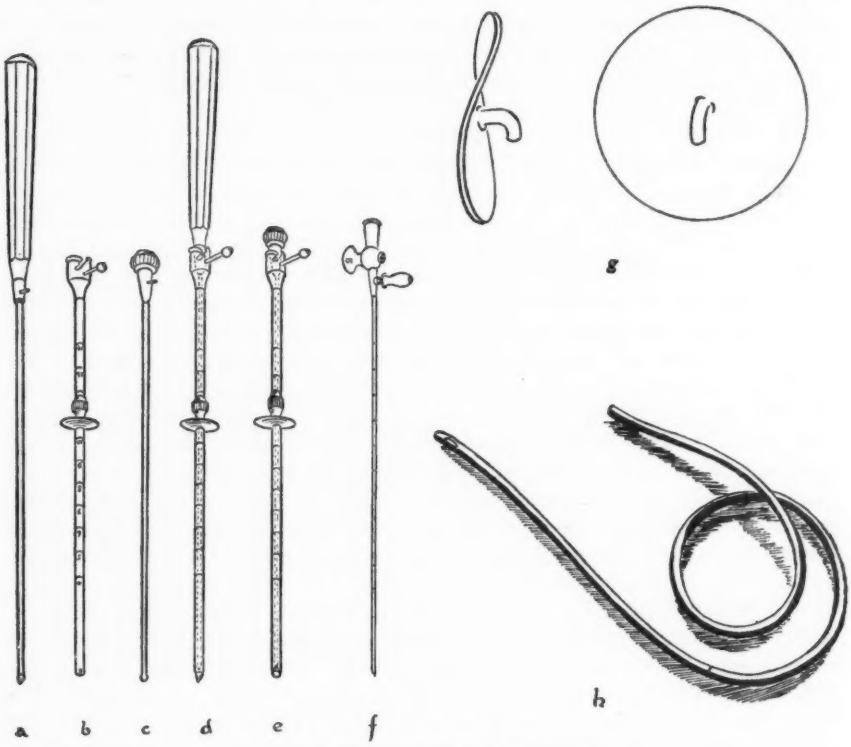

FIG. 1.—CAVITY DRAINAGE EQUIPMENT.

(*a*) Trocar; (*b*) Cannula; (*c*) Olive-ended trocar; (*d*) Trocar and cannula as used for initial cavity puncture; (*e*) Cannula with blunt trocar as employed for cavernoscopy or catheter re-insertion; (*f*) Cavity needle; (*g*) Flange and sheath; (*h*) Catheter.

rubber, No. 6 English gauge, 50 cm. long, with side openings. The rubber collar and flange provides a useful method of fixing the catheter to the skin.

Cavity Puncture.—The anterior route has been used in all our cases. Upper zone cavities were originally drained through the first interspace, as this is on a level with the centre of the cavity; but, since it was found that thoracoplasty was usually necessary to ensure lasting results, the second space has become the routine approach. This allows the first and second ribs to be removed *in toto* and an efficient Semb apicolysis to be carried down to the level of the second rib in front without risk of opening the catheter track. Davidson (1941)

reports a case in which this accident was followed by wound space infection with a fatal result.

Cavity puncture is most conveniently carried out in the operating theatre. Screen control during the procedure has not been found to be necessary. All the data required for successful puncture can be obtained from preliminary radioscopy and careful study of postero-anterior and lateral films taken with the X-ray tube centred on the cavity. These spot films are of great assistance in localising the cavity and estimating its depth. Puncture of an upper zone cavity from the second space is more difficult than from the first owing to the obliquity of the approach and the greater depth of the cavity, but here again careful study of the spot films and accurate estimation of the angle of trocar insertion usually render the operation easy.

A preliminary injection of omnopon and scopolamine is given an hour beforehand. The head of the operating table should be slightly lower than the foot to avoid cerebral air embolism. The chest wall is anæsthetised, taking care to inject some of the solution into the periosteum of the underlying rib as this will be pressed on by the cannula. Pleural fusion is again verified and the path to be taken by the trocar is then explored with a cavity needle attached to a pneumothorax apparatus. The resistance of the cavity wall and the sensation of penetration are not, as a rule, marked, and a free manometer swing may be the only indication that the cavity has been entered. The depth and direction of the needle having been noted, it is withdrawn, the skin incised, and the trocar and cannula, attached to a manometer, inserted. The pleura, particularly if it has been artificially fused, offers considerable resistance, but after this introduction is easy until the cavity wall is palpated at the depth already estimated from needling. The trocar, however, often perforates the cavity at a deeper level than the needle. This is due either to the trocar point indenting the wall for some distance before perforating it or to mobility of the cavity within the lung. Experience has shown that the cavity tends to move backwards, upwards, and medially. The trocar may glide off it, usually to the outer side, and the direction of the instrument will have to be correspondingly modified.

There is slight respiratory oscillation around zero as the trocar and cannula traverse the lung. Sometimes, after the point of the instrument encounters the resistance of the cavity wall, a negative pressure with respiratory oscillations develops and rises rapidly as insertion against an increasing resistance continues, until either the cavity is entered or the instrument withdrawn. This phenomenon is not observed when the sharp-pointed cavity needle is employed. It is apparently due to the advancing trocar and cannula indenting the cavity and stretching a zone of parenchyma outside its wall, while simultaneously kinking and obstructing the bronchi supplying the segment. If a superficial cavity is being drained, the reading is liable to be misinterpreted as an indication of a free pleura and lead to the postponement of drainage. This actually happened in one of our earlier cases. However, once the possibility of its occurrence is known, recognition, from the slightly deeper level at which the negative swing develops, should present no difficulty.

The sensation of overcome resistance and having entered an empty space are usually well marked as the cavity is perforated, and the manometer shows

large oscillations. The bronchus cavity valvular relationship having been investigated by air insufflation, exsufflation and breathing tests, the trocar is withdrawn and replaced by a paraffined No. 6 catheter on which the length of the cannula is marked. If the catheter can be pushed in easily beyond this mark, it is certain to be in the cavity. About 10 cm. are left in and the cannula is gently withdrawn over the tube. A dressing and flange are applied and fixed in position by an elastoplast corset (Fig. 3).

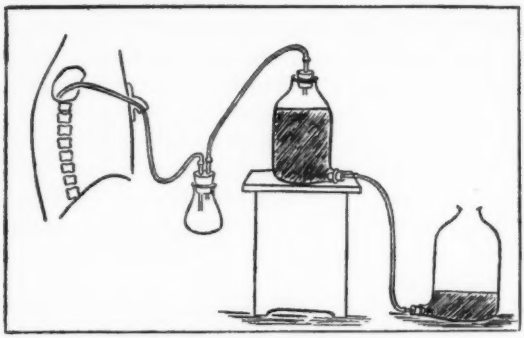

FIG. 2.—BOTTLE SUCTION.

Note that the two pieces of glass tubing in the trap bottle are unequal in length, the longer being connected with the patient. If the lengths are equal, secretion is sucked across the gap between the ends and fouls the whole tubing system.

Apparatus for Suction.—Bottle suction (Fig. 2) is recommended and used by Monaldi (1939) and Kupka (1940). It has the advantage of being simple and inexpensive. The upper bottle is connected to the catheter, and as water flows into the lower one, air is aspirated from the cavity. When the upper reservoir is empty, the bottles are reversed and the catheter connected with the full one by changing over the cork. The negative pressure exerted on the cavity is determined up to a point by the difference between the two water levels and consequently falls as the upper bottle empties. Monaldi believes that this variation in negative pressure is beneficial. The disadvantage of the system is that the frequent changing of bottles required if the drainage bronchus is fairly patent throws too great a strain on the nursing personnel. We prefer to use other means of aspiration in the earlier stages of treatment, and employ bottles only when the bronchial leak is minimal for long periods. They

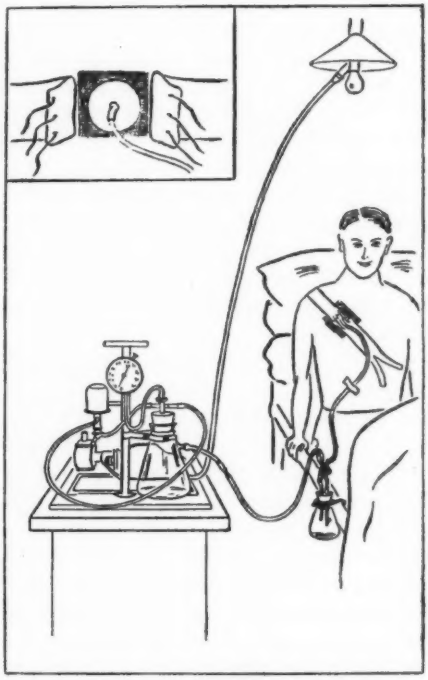

FIG. 3.—SUCTION WITH THE SMALL ELECTRIC PUMP.

The inset shows the method of catheter fixation by a rubber flange and sheath and an elastoplast corset.

are a useful part of the equipment in that at a certain stage of treatment they allow the release of electric suction apparatus for use in other cases.

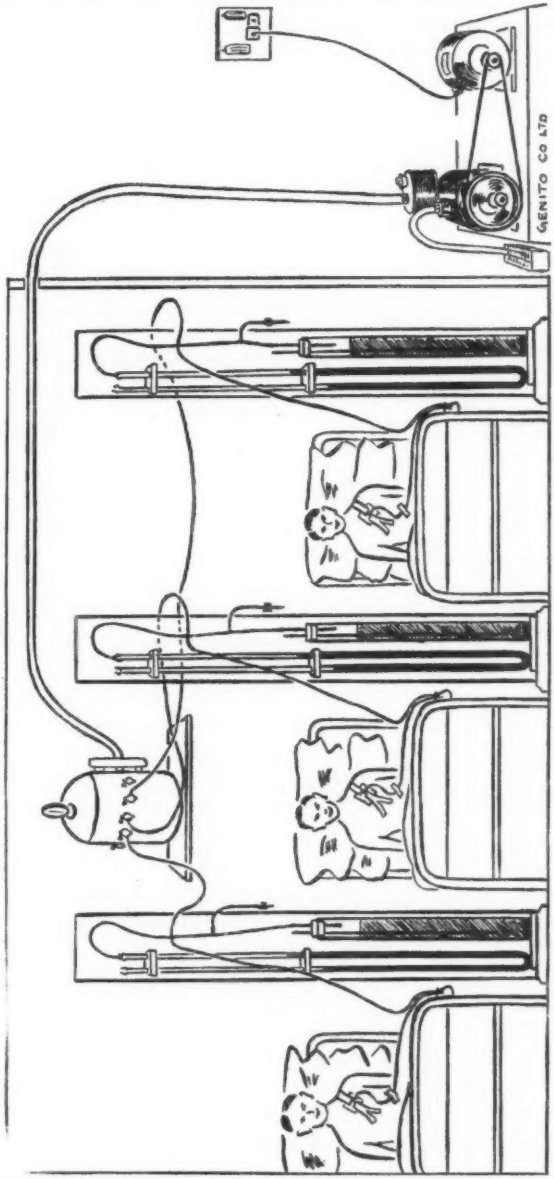

FIG. 4.—LARGE SUCTION PUMP AND VACUUM RESERVOIR.

The small electric suction unit (Fig. 3) comprises a pump with a volume displacement of 30 litres per hour—*i.e.*, about twice the volume of the pump commonly used for suction in empyemata, an anaeroid pressure gauge graduated

in centimetres of water, a vacuum bottle of 1-litre capacity, and a pressure regulator, consisting of a ball valve automatically controlled by a spring and a metal bellows, which maintains suction pressure constant at any adjusted level. This outfit is useful for the aspiration of single cases. It has the great advantage of extreme portability, can be plugged into any light connection, and enables the treatment to be continued on the balcony or in the rest shelter. The vacuum reservoir flask may be used as a trap, but for daily secretion measurement and sterilisation of the container it is more convenient to collect the secretion in a small Erlenmeyer bottle tied to the bed.

A large-volume vacuum installation (Fig. 4) enables aspiration of several cavities to be carried out simultaneously on the same suction system and seems the equipment of choice for a large institution. It consists of an electric pump with a volume displacement of 1,000 litres per hour, connected with a large metal reservoir of about 10 litres capacity in which a high vacuum can be built up. A gauge on the reservoir measures this pressure in inches of mercury. A series of adjustable taps are connected to the draining catheters. By regulating these taps and an air leak nearer the cavity, widely differing pressures, suited to each case, can be simultaneously maintained. As many as ten patients can be connected to this apparatus at the same time.

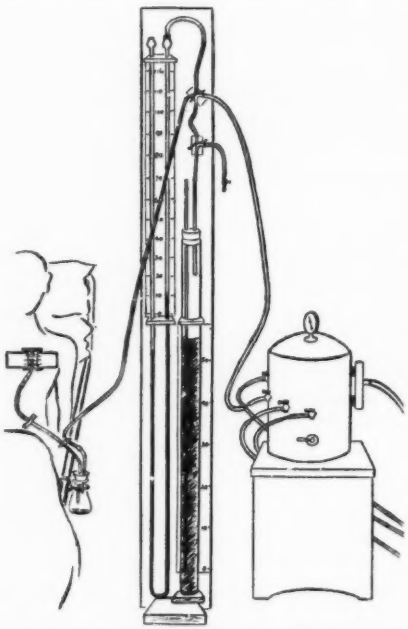

FIG. 5.—COMBINED WATER MANOMETER AND PRESSURE REGULATOR USED IN CONJUNCTION WITH THE UNIT FOR MULTIPLE SUCTION.

When this vacuum installation is employed for suction, a water manometer and pressure regulator, as devised by Jeanneret and Joyet (1940), are interposed between the reservoir and the trap bottle, as close to the latter as practicable. The pressure regulator (Fig. 5) consists of a glass cylinder 40 inches long by 2 inches wide, from a third to three-quarters full of water. The upper end is closed by a cork perforated by two glass tubes. The shorter of these is connected with the suction system and the pressure in the air chamber above the fluid is therefore the same as in the rest of the system about this point—*i.e.*, the pressure registered on the manometer. The longer glass tube is open to the outer air and dips into the fluid for a varying distance. Should the negative pressure in the suction system rise above the depth of this tube under the water, air is sucked down it and further rise prevented. The manometer, Jeanneret regulator and reservoir are joined together by a glass cross-piece, to the fourth limb of which is connected an adjustable leak consisting of a rubber tube fitted with

a screw clip for the fine adjustment of pressures. The pressure regulator may be used in two ways:

(*a*) It is set to the desired suction level—*e.g.*, 10 cm. Air constantly bubbles through the fluid and pressure cannot rise above this level.

(*b*) The long tube is placed at a much deeper level—*e.g.*, 60 cm.—and the manometer pressure is set at the lower suction level—*e.g.*, 15 cm.—by combined adjustment of the reservoir tap and the air leak. The Jeanneret safety valve leak now comes into action only when a tubing block occurs. The pressure in the system rises to 60 cm. and bubbling draws the patient's attention to the obstruction. A pressure of 60 cm., aided perhaps by a cough or two, as a rule clears a stoppage in the tubing.

The second method is preferable as it deals automatically with the tubing blocks which are a frequent occurrence. By contrast, sudden bronchial block is very uncommon and the risk of this high pressure being applied abruptly to the cavity is minimal. Its rare occurrence is proclaimed at once by tightness or pain in the chest and coughing, and all patients are instructed to deal with it immediately by fully opening the leak.

Management of Aspiration.—The patient is nursed flat for the first day and the catheter is connected with a trap bottle into which the secretions are allowed to drain. Continuous suction is not applied for twenty-four hours, but during this period the catheter is gently aspirated several times by means of a syringe. Usually air and some blood-stained pus are evacuated, but occasionally only air is obtained, and sometimes aspiration closes the draining bronchus, producing a vacuum which causes pulling back of the released syringe piston or a very audible sucking in of air when the catheter is reopened.

Next day the catheter is adjusted under screen control until the tip lies in a suitable position for drainage, and suction is begun at an initial pressure of −2 to −4 cm. of water. The pump is left on continuously during the day and switched off for the night. In the early stages the catheter often blocks and syringe clearance is required. The strength of aspiration is increased by a centimetre or two each week until a maximum intracavitary pressure of −15 cm. is reached. Higher negative pressures rupture the fragile capillaries of the newly-formed granulation tissue in the cavity wall. The intracavitary pressure is that registered on the manometer minus the amount of suction power lost by friction in the tubing, most of which can be estimated by inserting a second manometer in the same system at the outer end of the catheter and noting the difference in the two readings. Aspiration pressures as high as 15 cm. may not be necessary and it is best to leave suction at any lower pressure on which the cavity continues to diminish in size. The gradation of aspiration to suit the individual case is important. Too low pressures lead to insufficient drainage, frequent blocking of the catheter and arrest of cavity retraction. Too high suction causes excessive cough, dryness in the throat, pyrexia, malaise, profuse hæmorrhagic secretion and staining of the sputum. In our experience the cavities that close do so on negative pressures of 15 cm. or less.

Higher suction has been tried in cases that were responding sluggishly, but it has never been of permanent benefit and has often proved harmful. The cavities became smaller, but when high suction had to be reduced because

it was poorly tolerated, they re-enlarged. Intolerance was evidenced by pyrexia, loss of weight, and in some cases by exacerbation of other pulmonary foci. The symptoms were interpreted as due either to re-expansion of infiltrated pericavitary parenchyma or auto-tuberculinisation from increase of its blood supply. Monaldi (1939) states that excessive pericavitary congestion as a result of powerful suction may lead to embarrassment of the right heart. We have observed one case of temporary cardiac decompensation with ascites, enlargement of the liver and œdema of the extremities during a period of high suction, but it is uncertain whether this was true cardiac failure or mechanical embarrassment as a consequence of the considerable mediastinal displacement accompanying the rapid shrinkage of a large cavity.

The respiratory oscillation in intracavitary pressure is diminished by suction from the onset at the expense of the expiratory reading—that is to say, for any given strength of aspiration there is a relatively greater negative rise in expiration than in inspiration. As treatment continues, the swing becomes less and less, until finally, when the cavity is a simple fistulous track closely applied to the catheter and no longer expanding and contracting with respiration, it usually ceases altogether. However, in some cases, the respiratory variation in freedom of air ingress through the bronchi results in persistence or intermittent reappearance of the oscillation. The presence of a swing, therefore, does not exclude a cavity shrunken to a fistulous track around the catheter; an absent swing, if catheter and tubing are free, suggests cavity shrinkage of this degree but not necessarily a closed bronchus. It should be stressed that neither cessation of manometer oscillation nor inability to aspirate air from the catheter over prolonged periods are reliable criteria of bronchial closure. The only accurate method of ascertaining whether the bronchus is completely closed is by the injection of lipiodol or methylene blue through the catheter.

Sometimes an inverted suction swing, more negative on expiration than inspiration, develops, usually when the cavity has become small. There are two possible explanations of this phenomenon. One is that in expiration the cavity wall occludes the catheter opening and consequently the negative pressure in the vacuum system increases, while with inspiration the wall moves away from the catheter, the bronchial leak is re-established and the negative pressure falls. The other possible mechanism is a stenosed bronchus, closed in expiration but opening on inspiration, in the presence of a cavity so reduced in size that its respiratory variation in volume has become less important than the air flow factor in the production of the manometer swing.

Skin Puncture and Catheter.—The wound should be dressed daily. Exuberant granulation tissue around the opening of the track may require cauterisation from time to time. The mild inflammation which occurs occasionally responds readily to the application of heat.

The original catheter is left *in situ* as long as possible. The average life of radio-opaque tubing in the chest is about six months, but if sterilised frequently it is very much shorter. The side-opening catheter has proved more satisfactory than the end-opening type, which frequently becomes obstructed by the cavity wall. Reinsertion of a fresh catheter may be required if the rubber shows signs of perishing or the tube is accidentally expelled.

Spontaneous expulsion sometimes occurs in spite of most adequate fixation; an emphysematous patient in our series used to expel his catheter regularly about once a week.

In most cases reintroduction is easy; a well-paraffined catheter is simply inserted up the track to the desired depth. Occasionally, however, owing to marked angulation of the track at its junction with the residual cavity or stricture formation at the pleural or cavity level, catheter change presents considerable difficulty. Attempts to overcome this by threading the catheter over a metal stilette similar to the introducer for self-retaining catheters were unsatisfactory. The use of the drainage cannula with an olive-ended obturator specially designed for the purpose (Fig. 1, *e*) has greatly facilitated reinsertion. The cannula, which is attached to a manometer, passes easily along the track; when the cavity is reached, the trocar is removed and the catheter is passed down the cannula as at the initial operation.

Cavernography and Bronchography.—We have obtained valuable information about the cavity and its draining bronchi from serial cavernograms and bronchograms. After injection of iodised oil through the catheter under screen control, postero-anterior and lateral spot films are taken; as most of the oil run in during radioscopic examination leaves the cavity and bronchi rapidly if the latter are open, it is necessary to repeat the injection immediately before each exposure in order to ensure good bronchial filling. The procedure involves some risk of bronchogenic spread in the early stages of treatment (Fig. 10), and it is advisable, apart from one preliminary examination before or after catheterisation, to defer its use until the cavity secretions are free from tubercle bacilli.

Cavernography is of great assistance in following cavity retraction during the later stages of successful aspiration when it is usually impossible to distinguish the outline of the residual excavation on straight films or tomograms.

Ascending bronchography discloses the number of draining bronchi. We believe that this is an important guide to the pathogenesis of the cavity and the likelihood of its closure by suction drainage. Of the ten cavities investigated (Table I), three had one draining bronchus, two had two bronchi, one had three draining bronchi, and in four there were four or more bronchi. There appeared to be a definite relationship between the number of bronchi and the response to aspiration. Cavities with one or two bronchi readily diminished in size and closed on very low suction; if drainage was interrupted, they re-enlarged very slowly over many weeks or months. In three of the cases with four or more bronchi, closure of the cavity proved impossible (Fig. 9), and in the fourth case (Fig. 8), although closure is at last complete, it took nine instead of the usual two or three months. All these cavities re-enlarged rapidly when aspiration was interrupted. The failure to close was not related to any inability to maintain negative pressure in the cavities, nor to their size. The explanation probably is that cavities with one or two draining bronchi have developed mainly as the result of inflation with little loss of lung substance, while numerous bronchi indicate a cavity in the growth of which tissue destruction, either in the initial caseous focus or from continued ulceration, has played a considerable rôle. In these cases, the greater loss of lung substance, combined

perhaps with irreversible pericavitary atelectasis and more extensive fixation to the chest wall, usually precludes complete substitution of the cavity space.

The procedure also affords considerable information about the anatomical condition of the draining bronchi. They are often seen opening into the cavity at the bottom of small funnel- or pouch-shaped depressions which are frequently still visible when the bronchial lumina are temporarily closed. Filling defects representing constrictions of every degree up to apparently complete valvular obstruction are common; they may occur anywhere in the course of the bronchus but are usually seen as it traverses the cavity wall. This is in accordance with the post-mortem observations of Ameuille, Delhomme and Raust (1936) that the pathological changes leading to stenosis increase in extent and degree as the bronchus is followed towards the cavity. We noted, however, when bronchial closure of some duration developed, that the obstruction was most frequently at a distance from the cavity. The calibre of the different bronchi draining one cavity may range from a linear streak to several millimetres, and well-marked bronchiectasis is sometimes present.

Serial bronchography, lastly, is the most reliable method of confirming closure of the draining bronchi. While temporary obstruction is common, permanent occlusion is, in our experience, rare. It can only be assumed if the bronchus repeatedly fails to fill over a long period, and has happened only once in the series, in one of the multiple bronchi draining a cavity. Bronchial obliteration with persistence of cavity closure after removal of the tube is claimed in 20 per cent. of the 198 cases reported by Morelli (1939), but the method by which the diagnosis of bronchial closure was established is not stated.

Results

The first eleven cavities drained (Table I) were all reduced in size, seven of them to fistulous tracks around the catheter; but permanent closure of all the bronchial communications has not occurred in any case treated by suction alone, and the cavity has usually reappeared when drainage was interrupted.

Treatment has been terminated in three cases. In one (Table I, Case 9) the catheter has been out for seven months, and, although a small cavity re-appeared soon afterwards, it has shown no tendency to further enlargement. The sputum has recently become positive again, but the treated cavity may not be the source of this. In the second case (Case 11, Fig 10) the catheter has been withdrawn for three months and the cavity remains closed. In neither case had the draining bronchi closed, but in both cavities the pressure before drainage was constantly atmospheric. The third patient (Case 2, Fig. 7), after twenty months of drainage, became fit for and has been submitted to thoracoplasty; the catheter has been removed, the sinus has healed, and the cavity remains closed.

The catheter is still in place in three cases. One (Case 1, Fig. 6) has been under treatment for twenty-two months. The cavity shrank to a fistulous track within three months, but when the tube was partially withdrawn it reappeared and enlarged until drainage was re-established. Phrenic evulsion was performed and the catheter left in place in the hope that the bronchi would obliterate, but this result was not achieved. Drainage was been continued because, until this patient becomes suitable for thoracoplasty, we

PLATE I

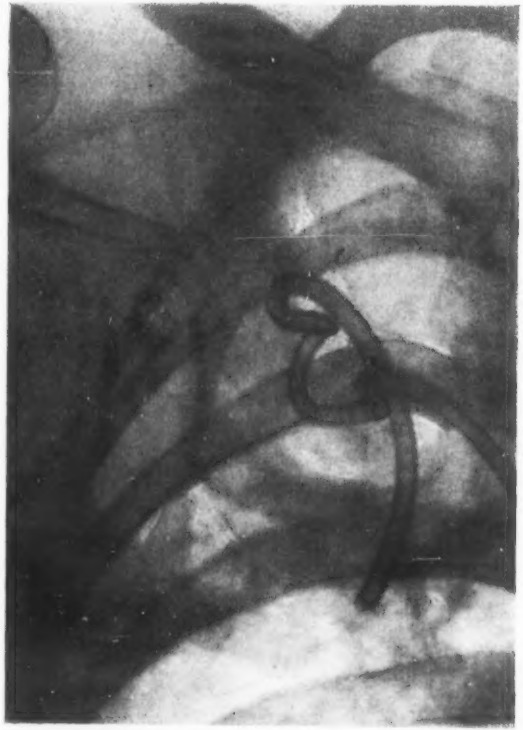

FIG. 6*a*.—(CASE 1, TABLE I) A RIGHT UPPER LOBE CAVITY.

Film taken immediately after catheterisation before the catheter had been shortened. There were two draining bronchi. Intracavitary pressure was around atmospheric, – 10 +8. The catheter has been introduced through the first interspace in front. The tip lies in a postero-inferior cavity pouch, which is fairly common but seldom visible on X-rays.

FIG. 6*b*.—MARKED REDUCTION IN SIZE AFTER FOUR WEEKS' DRAINAGE.

The circular shadow is the rubber flange used for catheter fixation.

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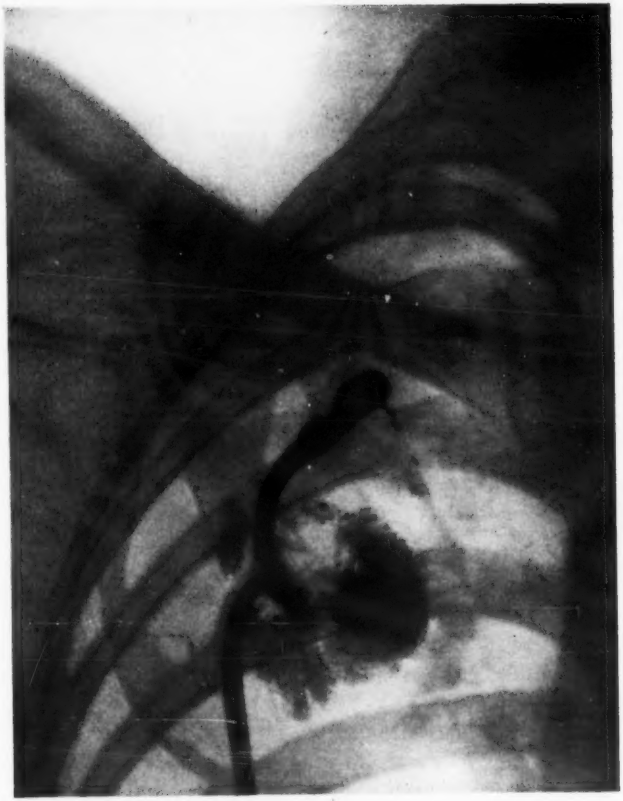

FIG. 6*c*.—CAVERNOGRAM AFTER SIXTEEN MONTHS' TREATMENT DURING A PERIOD OF TEMPORARY BRONCHIAL CLOSURE.

The fistulous track is small. One bronchus has filled for a centimetre, the other not at all. The opacity below is oil that has leaked back around the catheter on to the gauze dressing.

FIG. 6*d*.—CAVERNOGRAM ONE MONTH LATER.

The bronchi have re-opened. They run into the posterior division of the postero-lateral branch of the upper bronchus. Most upper zone cavities drain into this posterior branch. Note the irregular pouched lumen of the outer bronchus and the funnels entering the cavity. Both findings are frequent.

The fistulous track is small. One bronchus has filled for a centimetre, the other not at all. The opacity below is oil that has leaked back around the catheter on to the gauze dressing.

upper zone cavities drain into this posterior branch. Note the irregular pouched lumen of the outer bronchus and the funnels entering the cavity. Both findings are frequent.

PLATE III

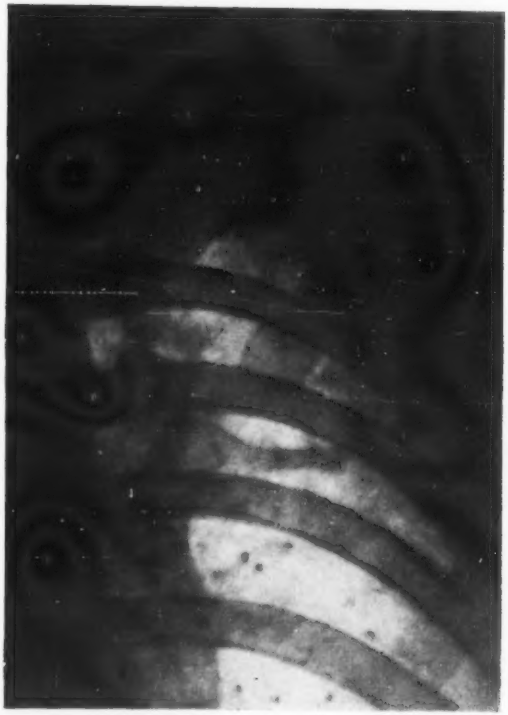

FIG. 7*a*. — (CASE 2, TABLE I) LEFT UPPER LOBE CAVITY SHORTLY BEFORE DRAINAGE.

The intracavitary pressures were −3 +7. There were three draining bronchi.

FIG. 7*b*.—CAVERNOGRAM AFTER A YEAR OF TREATMENT SHOWING THE NARROW FISTULA WHICH PERSISTS.

Only one bronchus was open at the time this film was made.

[*To face Plate II.*

PLATE IV

FIG. 7*c*.—CAVERNOGRAM TWO MONTHS LATER.

The catheter had been partially expelled some days before, and the cavity has re-enlarged. The walls are difficult to follow on this reproduction, but the width of the oil-level gives a clue to the size. Only one draining bronchus is open. The opacity inferomedially is oil that has leaked back on to the dressing.

FIG. 7*d*.—CAVERNOGRAM AFTER RE-INSERTION OF CATHETER.

There are now two open bronchi. This temporary closure is frequent. Three or four examinations may be necessary to show the total number of draining bronchi.

FIG. 7*e*.—CAVERNOGRAM AFTER A FIRST STAGE THORACOPLASTY OF FIVE RIBS WITH APICOLYSIS DOWN TO THE LEVEL OF 6TH RIB POSTERIORLY.

The fistulous track has moved downwards. All the bronchi are closed.

[*To face page* 35.

have no alternative therapy to offer. In two other cases the catheters have been in place for ten and twelve months, the cavities have been reduced to fistulous tracks, the sputa and secretions are negative for tubercle bacilli, but the bronchi remain open and the cavities enlarge again if drainage is interrupted (Case 5 and Case 8, Fig. 8). One of these patients has recently undergone a first-stage thoracoplasty and the other is now fit for surgical collapse.

Treatment has been abandoned in five cases, in four (Cases 3, 4, 7 and 10) because substitution of the cavity space was impossible, and in one (Case 6) owing to secondary hæmorrhage from the chest wall. All these cavities subsequently re-enlarged. In three cases small sinuses discharging pus or serum, and in two broncho-cutaneous fistulæ emitting air on cough, persisted after removal of the catheter.

We have applied drainage only when collapse therapy was impossible or contra-indicated, and in none of our cases was the cavity the only source of toxæmia. Perhaps for this reason we have not noted any striking immediate improvement in weight, temperature, general condition or sedimentation rate. None of the patients improved in whom the cavity response was poor. All of the seven cases in which the cavity was reduced to a fistulous track slowly gained weight; two of these, where the other pulmonary foci were not very active, almost immediately; and the remaining five, months after the establishment of drainage, when the lesions elsewhere in the lungs began to improve. Sputum conversion occurred in the nine patients with no other open focus within one to six months, the average time being ten weeks. Secretion conversion occurred in seven patients and took rather longer—on an average fourteen weeks. Tubercle bacilli were still present in the cavity secretion in five cases, when drainage was discontinued after from seven weeks to five and a half months.

The disappearance of fine cavitation around the treated cavity was noted in two cases.

Two patients (Cases 3 and 4) have died since the abandonment of treatment, but it is not considered that death was either accelerated or retarded as a result of it. Both were advanced cases, selected during our preliminary trial of the method, and would now be considered unsuitable.

Complications.—Air embolism, serious hæmorrhage or empyema have not been encountered as immediate sequelæ of cavity puncture. A localised convulsive seizure, possibly embolic in origin, of the arm, face and tongue on one side during the second month of drainage left no permanent damage (Case 3). Brisk hæmorrhage from the cavity occurred on several occasions during treatment in one case but ceased on interrupting aspiration for a few days (Case 4). Chest wall infection has been troublesome in only one patient, where the complication of secondary hæmorrhage could be controlled only by removal of the catheter and the application of pressure (Case 6). The temporary exacerbation of parenchymatous disease around a drained basal cavity in the third month of treatment was followed by the development of a pure tuberculous empyema in a homolateral extrapleural pneumothorax (Case 9). Spontaneous paralysis of the diaphragm on the same side occurred during the retraction of one upper lobe cavity (Case 5).

[To face page 35.

is open. The opacity inferomedially is oil that has leaked back on to the dressing.

Transient cardiac embarrassment was noted, as already mentioned, during the rapid shrinkage of one giant cavity (Case 7, Fig. 11). Temporary exacerbation of contralateral disease occurred in three patients, and it is thought that autotuberculinisation as a result of too powerful suction may have been responsible. Contralateral spread has not been observed in any case. Homolateral spread with cavitation occurred twice in the immediate neighbourhood of the drained cavity after the injection of iodised oil, but complete resolution followed within a few weeks (Fig. 10).

The Cavity-Bronchus Relationship.—Needling and measurement of intracavitary pressures soon demonstrated the fallacy of diagnosing a tension cavity from a single radiological examination; mean atmospheric pressures and expectoration of dye immediately after injection were common in large thin-walled spherical excavations with all the Röntgen characteristics of tension cavity. A more constant relationship was evident, however, between serial pressures and serial X-ray appearances. We noted that cavities in which the pressure continued to be atmospheric decreased in size or remained stationary over the period between the observations, while cavities with constantly positive pressures tended to enlarge, and cavities where pressures varied between atmospheric and positive were either enlarging or stationary. The diagnosis of a positive pressure cavity in the intact chest can therefore, as a rule, be made from an X-ray series but seldom with certainty from the study of a single film, as many cavities retain their tension appearance for a time after the initial phase of positive pressure has passed.

The following tests, carried out at cavity needling or puncture, provide a rough guide to the patency of the draining bronchi. The breath is held at the end of inspiration and expiration, and it is noted if the manometer pressures return to zero. For example, -7 cm. on inspiration and $+6$ on expiration, both returning promptly to zero, suggest bronchial communications freely open in both phases of respiration. A maintained positive expiratory pressure cannot, however, be regarded as conclusive evidence of expiratory bronchial occlusion, as many patients hold their breath in expiration with a closed glottis. Small amounts of air are then withdrawn and injected, and from the maintenance of the altered pressures or their rate of return to zero the presence or absence of stenosis and the type of valvular mechanism present may be deduced. Some idea of the relative patency of the bronchi in the respiratory phases may be obtained by noting whether the artificially altered pressures return towards zero in both respiratory phases or only during inspiration.

The trocar cannula, by virtue of its wider lumen, gives an ampler swing than the cavity needle, but less reliance is placed on valvular findings or mean cavity pressures recorded through the larger instrument. Air insufflation and withdrawal experiments with the cannula sometimes indicate cavity-bronchus and bronchus-cavity valves which are either absent or much less efficient when these tests are carried out through the cavity needle or drainage catheter, possibly because tenting of the cavity wall by the trocar and cannula persists after perforation and produces distortion and narrowing of the bronchial orifices. Again, the trocar and cannula, either as a result of straining or compression of the cavity during insertion, may create higher or lower mean

PLATE V

FIG. 8*a*. — (CASE 8, TABLE I) LEFT UPPER LOBE CAVITY IMMEDIATELY AFTER CATHETER INSERTION THROUGH THE SECOND SPACE.

Intracavitary pressures at one needling −4 +4, at another −1 +5. Volume approximately 180 c.c.

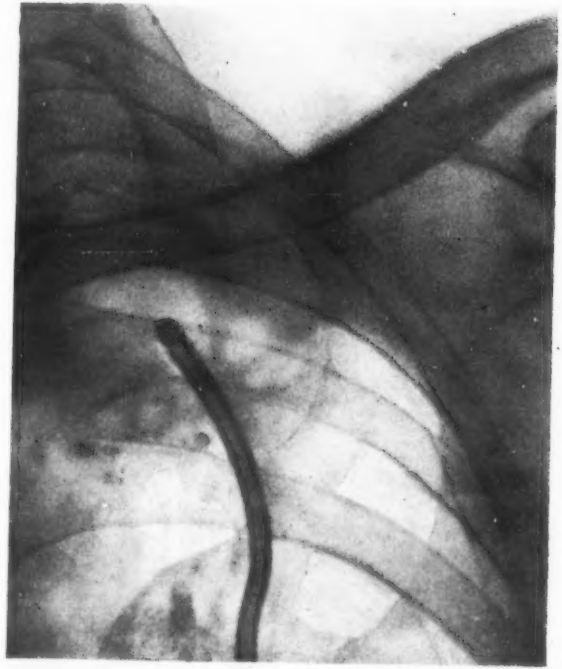

FIG. 8*b*.—CAVITY MUCH SMALLER AFTER FIVE WEEKS' SUCTION.

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PLATE VI

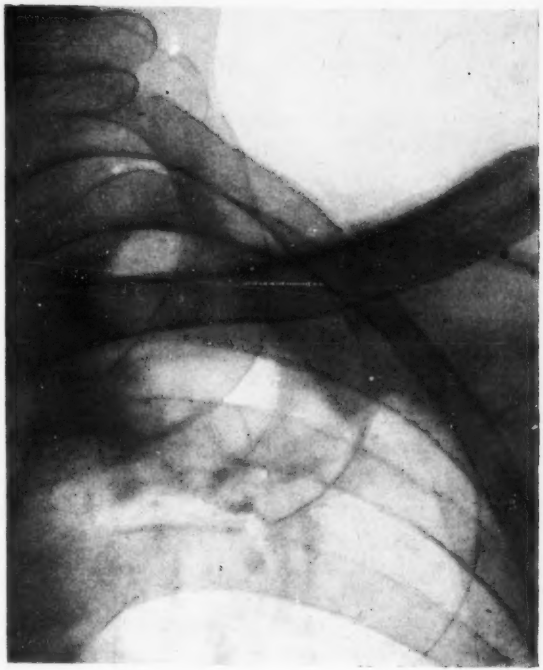

FIG. 8*c*.—THE CATHETER WAS PARTIALLY EXPELLED SOME DAYS BEFORE THIS FILM WAS TAKEN.

There has been rapid re-expansion of the cavity. Note the increased density around the catheter track.

FIG. 8*d*.—CAVERNOGRAM AFTER SEVEN MONTHS' DRAINAGE.

Residual cavity very small. There are four draining bronchi, three of them open in this film. This is the only cavity with four bronchi that has closed, and closure was very slow in the later stages.

FIG. 8*e*.—TOMOGRAPHIC CUT OF CATHETER AREA ABOUT THE SAME TIME AS THE LAST FILM, TO SHOW THAT THE CAVERNOGRAM IS MORE USEFUL AS A GUIDE TO THE SIZE OF THE RESIDUAL CAVITY.

[*To face Plate VII.*

very slow in the later stages.

[To face Plate VII.

PLATE VII

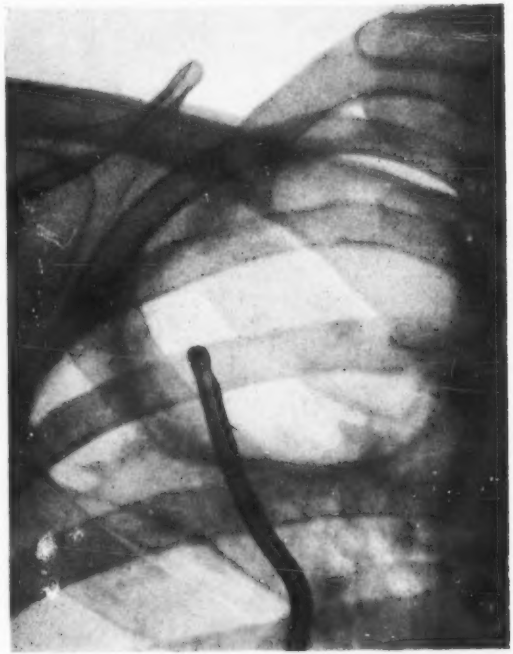

FIG. 9*a*. — (CASE 10, TABLE I) RIGHT UPPER LOBE CAVITY TWENTY-FOUR HOURS AFTER DRAINAGE.

The catheter has been shortened. This cavity did not close although it was thin-walled and the intra-cavitary pressure was positive, -2 $+9$ at one time and -3 $+7$ at another. The catheter has been inserted through the second space anteriorly.

FIG. 9*b*.—CAVERNOGRAM TWO MONTHS LATER, SHOWING THE MAXIMUM REDUCTION IN SIZE OBTAINABLE.

Note the four draining bronchi. Three of them are open in this film.

[To face Plate VI.

PLATE VIII

FIG. 10*a*. — (CASE 11, TABLE I) THIN-WALLED RIGHT UPPER LOBE CAVITY TWENTY-FOUR HOURS AFTER DRAINAGE THROUGH THE SECOND SPACE.

Intracavitary pressure constantly atmospheric. One draining bronchus.

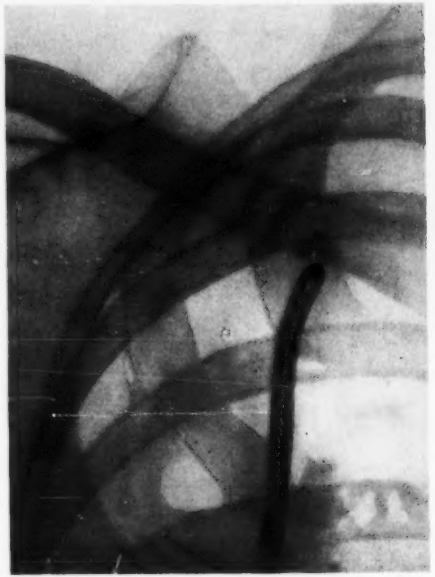

FIG. 10*b*.—AFTER TEN WEEKS' DRAINAGE.

The original cavity is no longer visible, but a fresh cavity has appeared in the second space following cavernography.

FIG. 10*c*.—CAVERNOGRAM FIVE AND A HALF WEEKS LATER.

The draining bronchus is still patent. Note the bronchus opening into the catheter track. The secondary cavity has disappeared.

[*To face page* 37.

pressures than existed in the intact cavity, and maintain them for a time by the same mechanism of bronchial distortion.

Intracavitary pressures recorded before drainage fall into three groups:

(*a*) Positive at each examination. The check valve mechanism responsible for the cavity enlargement persists. No completely efficient cavity-bronchus or inflationary check valve was encountered; in every case, as the pressure was artificially raised, a level was reached at which the valve allowed air to leak out of the cavity. Inspiratory pressures of – 1, – 2, or – 3 were frequent in the tension cavities (Table I). Air insufflation and breathing tests suggested that the draining bronchi of cavities with these inspiratory pressures are occluded in expiration but open in either direction during inspiration. As a result, the inspiratory pressure in the cavity can never rise for long above – 2. The present and other pressure series (Davidson, 1941) indicate that this is the commonest type of positive pressure cavity. Price Thomas (1942) refers to this two-way by-pass valve which, if the inspiratory cavity pressure rises, as a result of strain or cough, to a higher level than the intrabronchial (– 2), allows air to flow out of the cavity into the bronchial tree during inspiration.

(*b*) Pressure positive at one time, atmospheric at another. The original cavity-bronchus check valve reappears during bronchial narrowing by secretion or exacerbation of inflammatory changes. In cavities with multiple bronchi the pressure will vary with the presence or absence of cavity-bronchus check valves in the bronchi open at the time of examination.

(*c*) Pressures about atmospheric at each examination: (i) With bronchi widely patent in both phases of respiration. It has been noted in these cases that, although the pressures are atmospheric on quiet breathing, they move towards the positive side when respiration deepens. (ii) With bronchial stenosis which produces hindrance to free air flow from bronchial tree to cavity—*i.e.*, a bronchus-cavity or deflationary check valve. This is usually associated with a weaker valve in the cavity-bronchus direction, but the important point is that air can leave the cavity more rapidly and easily than it enters. In these cavities, the pressure actually moves to the negative side when respiration deepens.

Example: Cavity pressures – 3+3 to – 4+3; on deeper breathing – 11+4; 20 c.c. of air withdrawn – 27 – 21, three minutes later, – 19 – 15; 30 c.c. of air in, +6+11, returning to zero in a few seconds.

Another example of a less efficient valve: Pressures – 2+2; on deeper breathing – 10+5; 60 c.c. of air off, – 22 – 9. A minute later, – 13 – 0; 60 c.c. of air in, +3+9, falling within twenty seconds to – 5+6.

Experience suggests that weak valves of this type are not infrequent. If more efficient forms develop with advancing bronchial stenosis, they may well constitute one mechanism of spontaneous cavity closure. The explanation of the coexistence of an atmospheric cavity pressure with such a valve mechanism may be either that the valve is produced or reinforced by cavity deflation, or that only stationary cavities with weak valves, and not contracting cavities with markedly negative pressures and efficient valves, are encountered when needling is performed as a preliminary to possible cavity drainage.

The one cavity in our series which has not reappeared at all since the catheter was withdrawn (Case 11, Table I) had a single bronchus with a valve mechanism of this type before drainage. This suggests to us that the presence of such a valve may explain many of the reported cases of apparently permanent cavity closure by drainage therapy alone, hitherto ascribed to bronchial obliteration. In our case the effect of cavity drainage was to strengthen the deflationary valve. This may have been due to approximation of the walls of the funnel, through which, as demonstrated by lipiodol instillation, the bronchus opened into the cavity. That the valve was not abolished by drainage was not unexpected, as it had already been observed in studying the cavity-bronchus, or inflationary valves, that they might be weakened or strengthened, but did not disappear as a result of drainage. This thin-walled cavity could always be emptied by aspiration of air with a syringe and pressures of – 90 cm. of water maintained for some minutes without apparent inleak from the bronchus, although air and lipiodol flowed freely in the opposite direction from the cavity into the bronchial tree. Syringe aspiration produced first air and then secretion, or secretion and afterwards air. Cavity emptying has been watched on the screen. When the tip of the catheter lay in the upper part of the cavity, the walls were approximated as air was evacuated, and the pool of secretion rose until it reached the catheter opening. If the catheter tip lay on the lower pole of the cavity, the pool of secretion was seen to disappear first, then air was aspirated and the cavity contracted rapidly. Finally, no more air or pus was aspirable and the cavity translucency was no longer visible; if the catheter was now reopened to the outer air there was a loud sucking sound and the cavity translucency suddenly reappeared on the screen. Emptying of this thin-walled cavity provoked a little tightness locally in the chest but never cough. Voluntary coughing did not open the bronchus. In another bronchus-cavity valve case which has been undergoing drainage for a few weeks, we have constantly been able to make the cavity disappear by aspiration without causing more than slight tightness in the throat, insufficient to provoke cough.

Eloesser (1941) describes cavities of this type, in which aspiration led to apparent radiological disappearance for some hours or days, and Rogers (quoted by Eloesser) practises emptying them immediately before performing thoracoplasty. However, we found that it was not possible to empty every cavity with a bronchus-cavity valvular action by aspirating air. Intermittent closure of the bronchi during syringe aspiration was fairly frequent in the early weeks of drainage in cavities with few and stenotic bronchi, whatever the predominating type of valvular mechanism. In many of these cases the quantity of air removable was considerably less than the cavity volume. Further increase of suction force in an attempt to completely deflate the cavity caused local pain in the chest, and then, if persisted in further, coughing, which led to immediate reopening of the bronchus. Apparently, when the cavity wall is rigid, even if the valve is efficient enough to withstand the negative intracavitary pressure created by aspiration, this pressure provokes cough, and the high positive intrabronchial pressure in combination with the negative intracavitary pressure overcomes the valve mechanism.

The average intracavitary cough pressure was about +45 cm. of water,

PLATE IX

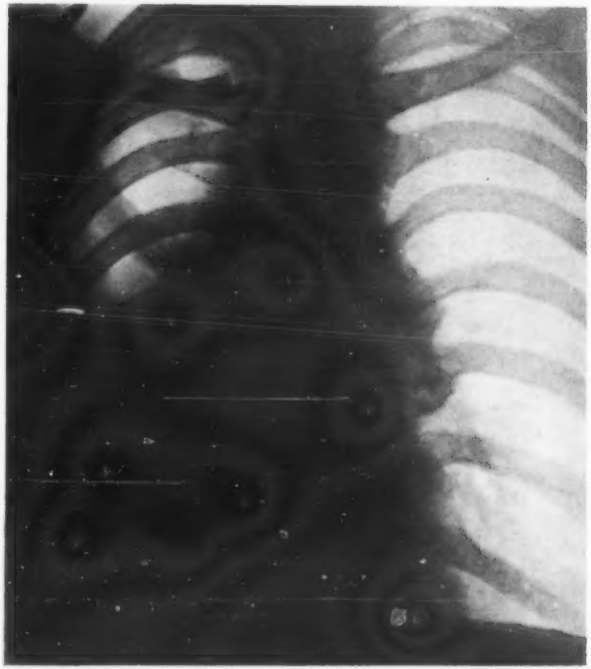

FIG. 11*a*. — (CASE 7, TABLE I) GIANT CAVITY IN RIGHT LUNG.

Volume approximately 650 c.c. Pressures at one time 0 +8, at another −6 +7.

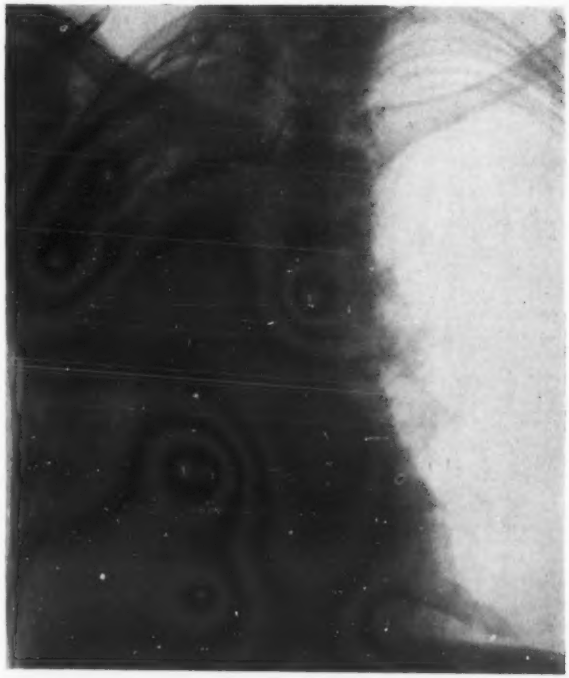

FIG. 11*b*.—AFTER TWO MONTHS' DRAINAGE.

Cavity reduced to about 100 c.c. in volume. Re-expansion of atelectasis at base.

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PLATE X

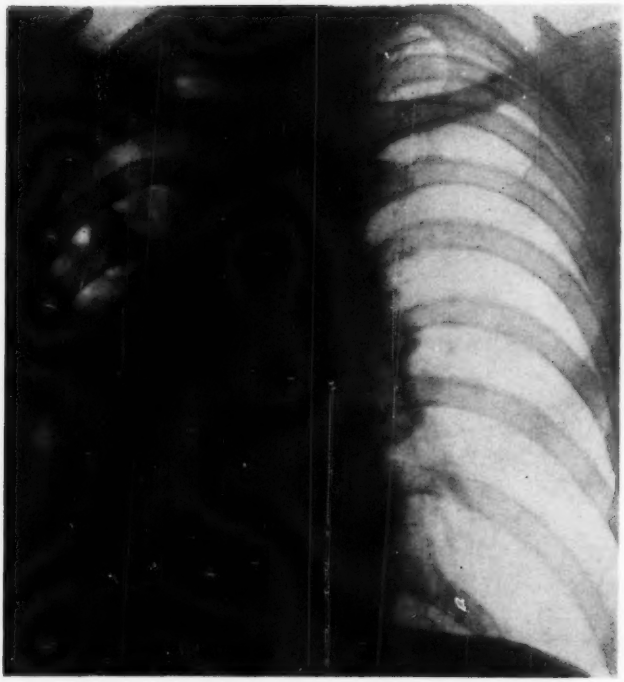

FIG. 11*c*.—TWO MONTHS AFTER ABANDONMENT OF DRAINAGE.

The cavity has re-enlarged almost to its original size, but aeration of some of the re-expanded lung at the base persists.

[*To face page* 39.

but in one giant cavity with very patent bronchial communications positive pressures of 130 cm. were recorded.

During drainage the patency of the bronchi can be roughly ascertained by withdrawing and injecting air through the catheter with a pneumothorax apparatus and correlating the rate of flow from the water reservoirs with the respiratory phases. In the early stages of drainage, when the cavity is still large, as the bore of the catheter is usually much wider than the sum of the bronchial lumina, the findings are the same as when dealing with a pneumothorax—that is, air flows in rapidly during inspiration and slowly in expiration, while, on withdrawing air, the flow quickens in expiration and slows on inspiration. In other words, the cavity variation in volume is the chief factor determining the flow at this stage. Later, as the cavity becomes smaller, its volume changes are no longer a factor of importance and the findings alter; air flow in and out is rapid on inspiration and slowed or even arrested during expiration. In some cases, the arrest of flow extends from expiration into inspiration and occasionally the flow is only momentary at the height of inspiration. The variation in rate of flow is interpreted as an indication of bronchial widening during inspiration and contraction during expiration; arrest of flow in expiration as an indication of stenosis sufficient to cause bronchial closure in this phase; and extension of the arrest into inspiration as an indication of more advanced stenosis Arrest of flow can often be overcome by increasing the force of injection or aspiration. The head of pressure required to do this is regarded as an indication of the strength of the valvular mechanism present.

These tests are, of course, only a reliable guide to the state of bronchial patency when a residual cavity of sufficient size is present to allow radiological adjustment of the catheter so that its opening is not in contact with the cavity wall. When the excavation has shrunk to a fistulous track, they are no longer of value as the wall of the track either obstructs the catheter orifice completely or, by opening it in inspiration and closing it in expiration, becomes an important factor in modifying the rate of flow.

Observations on the cavity-bronchus relationship showed that in some cases stenosed bronchi became wider during treatment, but that despite the widening, pre-existing cavity-bronchus check valves persisted. In other cases bronchial stenosis appeared to increase. The effect of phrenic paralysis on the draining bronchus of an upper lobe cavity was slight bronchial narrowing leading to increased efficiency of the cavity-bronchus check valve. In a basal cavity the bronchial narrowing following diaphragmatic rise was so marked that the bronchi were closed completely during normal inspiration and opened only at the end of deep inspiration.

Contrary to expectation, there was no constant relationship between the intracavitary pressure and the response to drainage (Table I). Some cavities were reduced to fistulous tracks and others failed to shrink completely, in both the mean atmospheric and the mean positive pressure groups. It would seem that the number of draining bronchi is a better indication of the probable response than the cavity pressures. It is possible, however, that the intracavitary pressure, while no guide to the immediate response, may be important in assessing whether a cavity which has shrunk to a catheter track is likely to

TABLE I.

Case Number.	*Cavity Site.*	*Cavity Volume.*	*Cavity Pressures.*	*Draining Bronchi.*	*Other Foci.*	*Sputum Conversion.*	*Secretion Conversion.*	*Results.*
1 (Fig. 6)	R.U.L.	155 c.c.	−10+8	2	Active bilateral infiltration. Condition slowly deteriorating on bed rest	11 weeks	16 weeks	Local response rapid. Cavity a fistulous track within 3 months. Bronchi not closed, although catheter in for 22 months and phrenic avulsion added. Cavity re-enlarges if catheter is withdrawn. Radiological improvement in other foci began some months after drainage; slow improvement in general condition a year afterwards.
2 (Fig. 7)	L.U.L.	155 c.c.	−3+7	3	Bilateral activity. General condition improving	34 weeks	22 weeks	Drained 19 months. Cavity a fistulous track in 3 months. Late improvement in general condition and other pulmonary foci. One bronchus closed permanently on suction; other two after thoracoplasty with extrafascial apicolysis. Catheter removed. Sinus healed. No sputum.
3	R.U.L.	460 c.c.	−2+10	More than 4	Gross bilateral disease. Tb. empyema and laryngitis. General condition very poor	Not converted	Not converted	Drained 3 months. Cavity volume reduced to two-thirds. General condition deteriorated. Cavity rapidly re-enlarged on abandoning suction. Death 5 weeks later. Sinus persisted.
4	Left Apex	45 c.c.	−6+6 −2+10	4	Gross bilateral disease with cavitation. General condition steadily deteriorating	Not converted	Not converted	Cavity retracted to half pre-drainage size No further reduction obtainable in 6 months. Deterioration in general condition continued. Moderate hæmorrhage from catheter on several occasions. Died 8 weeks after drainage abandoned. Fistula discharging pus and air until death.
5 Drainage	R.U.L.	80 c.c.	−1+9	1	Active bilateral disease. Diabetes	6 weeks	Not in 11 weeks	Local and general response good. Gained ½ stone in weight. Catheter expelled after 11 weeks, when cavity was a fistulous track, and could not be reinserted. Cavity slowly re-enlarged and reached original size in 6 months, but steady gain in weight continued. Sinus persisted until redrainage 6 months later.
5 Redrainage	R.U.L.	80 c.c.	−5+10	1	—	11 weeks	11 weeks	Local response good. Slight deterioration in general condition and mild temporary exacerbation of contralateral disease followed redrainage. Cavity now a fistulous track, but bronchus still open after 10 months' drainage.
6	R.U.L.	50 c.c.	−8+8	1	Bilateral disease			

age								tion of contralateral disease followed reëmbarge. Cavity now a fistulous track, but bronchus still open after 10 months' drainage.
6	R.U.L.	50 c.c.	−8+8 −4+10	1	Bilateral disease. Emphysema	3½ weeks	Not converted	Cavity response rapid. Drainage terminated in seventh week for severe secondary hæmorrhage from chest wall. Sputum positive again. Sinus persists.
7 (Fig. 11)	Right lung	650 c.c.	−6+7	Not investigated	No active bilateral disease. Too old for thoracoplasty	26 weeks	26 weeks	Cavity reduced to 100 c.c. by high suction. Temporary cardiac decompensation. Drained 8 months. Enlarged rapidly on abandoning drainage, not quite to original size. Sputum T.B.-positive again and sinus present 4 months later.
8 (Fig. 8)	L.U.L.	180 c.c.	−4+4 −1+5	4	Active bilateral disease. General condition stationary	4 weeks	4 weeks	Drained 12 months. Rapid shrinkage for 6 weeks. Further closure very slow and reduction to a fistulous track took 9 months. Immediate improvement in general condition. Undergoing thoracoplasty. Draining bronchi not closed by a first stage of three ribs without apicolysis.
9	Left lower lobe	75 c.c.	−4+6 −8+5	2	Contralateral intrapleural A.P. Homolateral extrapleural A.P.	30 weeks	8 weeks	Cavity a fistulous track in 2 months. Phrenic avulsion added. Catheter removed after 7 months' drainage. Sinus healed. Small residual cavity persists but does not enlarge. Sputum became T.B.-positive again 4 months after drainage abandoned. Bilateral effusion during treatment. Fluid persists and is purulent on the left side. General condition deteriorated temporarily, but is now better than before drainage.
10 (Fig. 9)	R.U.L.	180 c.c.	−2+9 −3+7	4	Active bilateral disease. Slow deterioration	12 weeks	Not converted	Cavity reduced to 85 c.c. in 2 months but no further. Temporary exacerbation of contralateral disease. Drainage abandoned after 4 months. Cavity re-enlarged. Fistula persists 4 months later. Sputum positive again.
11 (Fig. 10)	R.U.L.	35 c.c.	−3+4 −4+6	1	Unilateral disease. Too old for thoracoplasty	6 weeks	15 weeks	Cavity responded rapidly but bronchus did not close. Drained for 7 months. Tube out for 3 months, sinus healed and cavity not reappeared. Homolobar spread and cavitation occurred early in treatment following lipiodol injection. Complete resolution in a few weeks.

Cavity volumes are calculated from the formulæ: (*a*) $4/3\ \pi r^3$ for the spherical cavities, and (*b*) $4/3\ \pi abc$ for the ellipsoidal cavities, *a*, *b*, and *c* being the semi-axes of the ellipses.

remain so without ancillary methods of treatment. Further experience will show if it is of significance that, while cavities with constantly or intermittently positive predrainage pressures tended to re-expand after removal of the tube, the two cavities in our series which have not re-enlarged to any great extent were those in which the pressures were constantly atmospheric before drainage. It should, however, be remembered in this connection that, in the presence of freely patent bronchi, mean cavity pressures which were atmospheric during normal breathing moved towards the positive side on deeper respiration. This finding suggests that while such cavities may not reinflate under the quiet conditions of sanatorium life, they are more likely to do so, when a more active existence is resumed, than the atmospheric pressure cavities drained by stenotic bronchi with a predominantly bronchus-cavity check valve action.

Selection of Cases

Our present practice is to attempt to assess the probable response to drainage by preliminary radiological, bronchographic, and serial pressure investigations. Cavities fall into one of three groups:

(*a*) The cavity likely to be closed by drainage alone. The ideal case is the isolated thin-walled cavity with a constantly atmospheric predrainage pressure and a single stenotic draining bronchus which allows air to leave the cavity more easily than to enter it. It is obvious that only a small percentage of cavities will fulfil these conditions.

(*b*) The cavity likely to be temporarily reduced to a fistulous track by aspiration but requiring thoracoplasty for permanent closure. Any cavity of moderate size with three or fewer draining bronchi and constantly or intermittently positive predrainage pressures. The cavity with atmospheric pressures and a single freely patent bronchus probably belongs to this group.

(*c*) Cavities unlikely to shrink completely on drainage. Large cavities with four or more draining bronchi or, conversely, with a single large—segmental or lobar—bronchus.

Discussion

While suction drainage undoubtedly produces temporary cavity closure and elimination of tuberculous disease from the cavity wall in a high proportion of the treated cases, bronchial obliteration is an infrequent end result of aspiration *per se*, and, as a consequence, only a minority of cavities remain closed when treatment ceases. In the majority, thoracoplastic collapse is necessary to ensure permanency of the closure. Drainage cannot, therefore, at present be considered as an alternative to collapse therapy, and it is seldom justifiable to undertake it in a patient who is suitable for surgical collapse in the hope of avoiding operation. However, carefully managed cavity aspiration may, in conjunction with prolonged general treatment, improve the otherwise hopeless patient. We consider that its most suitable application is as a preliminary to surgical collapse in a group of patients hitherto beyond medical aid, the stationary or slowly deteriorating chronic cases that never become fit for the thoracoplasty which would be their best chance of recovery. In these patients, drainage, by controlling the cavity and eliminating it as a source of toxæmia and further bronchogenic spread, may lead to regression of extra-

cavitary disease and improvement in general condition to an extent which renders thoracoplasty a reasonable risk. Aspiration should also be of value as an adjunct to thoracoplasty in the treatment of the giant cavity, and its employment as a preliminary measure in patients with abundant expectoration might be expected to reduce the incidence of post-operative pulmonary complications. As to the future of the procedure, we believe that the problem to be attacked is the closure of the draining bronchi by means less drastic than thoracoplasty. If this could be achieved by some simple transcavitary method, the scope of cavity aspiration would be considerably widened.

Summary

1. The technique of puncturing cavities and the management of their aspiration are described.

2. The results are presented of draining cavities in eleven cases.

3. Drainage rarely produces permanent bronchial obliteration.

4. The best guide to the likelihood of a cavity being reduced to a fistulous track by aspiration is the number of bronchi which drain it.

5. Only a small percentage of cavities remain as tracks when the catheter is removed. It is suggested that apparently permanent closure of these cavities is not the result of bronchial occlusion. The most favourable factors guiding pre-operative selection seem to be a constant atmospheric pressure and a single stenotic bronchus in which the bronchus-cavity is more efficient than the cavity-bronchus check valve.

6. In most cases the cavity reopens when drainage is abandoned. Aspiration, therefore, is usually a preliminary to thoracoplasty. The indications for its employment are discussed.

We wish to thank Dr. Allison, Medical Superintendent of the Surrey County Sanatorium, for permission to publish these cases.

We are indebted to Mr. Price Thomas and Mr. N. R. Barrett for their great help and interest in this work, and to Mr. Schranz, of the Genito-Urinary Company, for the time and patience he has given to the elaboration of the equipment.

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ARTIFICIAL BRONCHIAL OCCLUSION BY PLASMA CLOT IN THE TREATMENT OF CHRONIC TUBERCULOUS CAVITATION

PRELIMINARY REPORT

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Many authorities believe that the main cause of a persisting tuberculous cavity in the lung is a free entry of air into it through its communicating bronchi. Thus various attempts have been made to heal cavities by occluding their bronchi, using such methods as cauterisation or the introduction of rubber balloons. In this preliminary report we wish to describe a method, found in some measure to be successful, consisting of the introduction into the cavity of plasma which subsequently clots in the bronchi and plugs them.

We have applied the method to six patients on whom transpleural cavity drainage (Monaldi technique) had been in progress from two to twelve months. The discharges had become free of tubercle bacilli but the cavities had not closed. In all of them communicating bronchi could be demonstrated, and it had been found that, although the cavities could be reduced in size by a suction pump, cessation of the suction resulted in their re-expansion.

Plasma was obtained in each case from the patient's blood and injected through the drainage catheter immediately before it clotted. At first, to render the injection mass radio-opaque, we added Pyelosil (Glaxo) and found this had the beneficial effect of reducing the contraction of the clot. We therefore continued to use it although in so low a concentration that its radio-opacity is but slight. Since it had the effect of lengthening the clotting time, we found it necessary to add Stypven B.W. (snake venom).

Procedure

On the day that an injection is made 20 c.c. of blood are taken from the patient and placed in a sterile tube, prepared by evaporating to dryness 2 c.c. of a 1·34 per cent. solution of sodium oxalate. The oxalated blood is then centrifuged and the plasma taken off. To determine its clotting time a trial sample of 1 c.c. is placed in a test tube of 1 cm. diameter, and 0·2 c.c. of Pyelosil and 0·8 c.c. Stypven are added and mixed. Finally, 0·1 c.c. of 4·5 per cent. anhydrous calcium chloride is added, and from the moment of mixing the clotting time is accurately determined by means of a stop watch. The tube should then be gently tilted from side to side to observe the onset of clotting, but should not be shaken. At room temperature the time may vary from one to three minutes, but if it is inconveniently long the amount of Stypven can be raised to 1·2 c.c. and the time again determined.

Immediately before the injection is made the drainage catheter is changed. Under sterile conditions the volume of plasma to be injected is then mixed with Pyelosil, Stypven and calcium chloride in the proportions indicated by

the results of the test, but the calcium chloride must be added last, and the time of mixing noted with a stop watch. The mixture is then placed in a syringe and injected into the cavity via the drainage catheter during the last thirty seconds before it is due to clot. The injection may be carried out with the patient in a sitting position, or standing behind an X-ray screen, but generally it is best performed with his position adjusted so that there is a slow flow of the plasma into the bronchi. As much as 10 c.c. may be injected on the first occasion. The aim is to fill the cavity and its draining bronchi at one operation, but in the case of large cavities repeated injections may be required and increasing amounts may be given. If many injections are given antibodies are developed against the Stypven and other human plasma must then be used. Following the operation the catheter is kept closed and left undisturbed for a few days. No suction drainage is applied.

The most important precaution to be taken is the instruction to the patient to resist with all his power the impulse to cough, not only at the operation but in the first two or three days following. A sedative linctus may be given, but in spite of it patients yield to the impulse. Fortunately, at a second operation they know what to expect and are usually better able to resist. Patients have reported that except for a few minutes during the operation the injection has allayed their cough and diminished their sputum.

Results

The best demonstrations of what happens to the injected mass have been given by patients who have coughed it up. Casts of the bronchi, up to 3 inches in length, and often in complicated branching formations, have been produced. In some cases, where the injection has been retained, its presence in the bronchi has been demonstrated radiographically. In several cases at least temporary occlusion of the bronchi has been proved by the absence of oscillation of the air pressure in the cavity, after the introduction of a clean catheter. In three cases continued blocking was shown by repeated cavernograms.

The following is a summary of our experience of the method (clinical details will be given in a subsequent publication):

Case 1.—*First injection* coughed up within a few minutes, as a very complicated bronchial cast. *Second injection*, a week later, part coughed up as a smaller cast, but some retained. *Third injection*, a week later, a little coughed up but most retained. Bronchi now blocked and cavity obliterated.

Case 2.—*First injection*, remained in position blocking bronchus and filling cavity for one week. Bronchus then became patent and cavity reappeared. *Second injection*, fourteen days after the first retained. Bronchus occluded and cavity filled. Occlusion has now continued for two months, the cavity remaining obliterated.

Case 3.—*First injection* retained entirely. Bronchus occluded for a week and cavity not visible. Catheter then removed. Cavity reappeared at tenth day but has remained small and half filled with fluid.

Case 4.—*First injection:* first part coughed up within a few minutes as a large complicated bronchial cast, the rest retained. Bronchi occluded for fourteen days, during which the clot apparently became digested by streptococcal infection. Cavity then rapidly re-expanded.

CASE 5.—(Unusually large cavity with four large draining bronchi.) *First two injections*, at intervals of four days, both coughed up apparently entire. *Third injection*, a fortnight after first, retained in part. Lower bronchus occluded, and cavity reduced in size. *Further three injections*, at ten days' intervals; two other bronchi blocked and cavity still smaller. Only one bronchus now remaining open.

CASE 6.—*First injection* coughed up after eighteen hours. *Second injection* a week later (containing Promanide), retained entirely.

Discussion

The use of fibrin was an attempt on our part to imitate what we assume is a natural method of bronchial closure—namely, organisation of an inflammatory exudate in the lumen. To take the place of an exudate we have introduced fibrin in the form of plasma clot. Animal experiments have shown us that autogenous plasma, treated as in our human experiments, is capable of becoming organised. Subcutaneous injections of 2 or 3 c.c. into rabbits have shown complete organisation in ten to fourteen days.

In our experiments on human beings we have purposely avoided using antiseptics so as to make the issue a simple one—namely, the effect of mechanical blocking of the bronchi, but in Case 4 our result was vitiated by a pre-existing streptococcal infection. The addition of sulphonamides might at first sight appear to be the solution of this difficulty, but we have found that these substances dissolved in the plasma seriously impede its clotting, so restricting the concentrations which can be used. The introduction of Promanide was suggested to us by Professor W. H. Tytler, who, with Dr. A. D. Lapp, has applied it locally to tuberculous sinuses and superficial abscesses with promising results, a report of which is now in the press. This drug is the didextrose sulphonate of diaminodiphenylsulphone, known in America as Promin, and now registered in this country as Promanide. Its antibacterial action is not confined to the tubercle bacillus, and we find we can conveniently use it in 2·5 per cent. concentration in plasma. Injected into rabbits in this concentration it appears to excite fibroblastic activity, and so we have been encouraged to try it on one patient (Case 6), without ill effect.

Conclusions

Although these investigations are few and incomplete as yet, they show, in three cases, that successful bronchial occlusion can be achieved by the method for considerable periods with beneficial results. The application of the method and its value in the care of the tuberculous are now being studied, and will be the subject of a later communication. The trials reported here provide one interesting deduction, for they strongly support the view that chronic tuberculous cavities tend to contract and disappear when their draining bronchi are blocked and to enlarge when their bronchi are reopened.

We are indebted to Dr. William Davies, Medical Superintendent of the Sully Hospital, for his most helpful co-operation; to Mr. C. Price Thomas for his encouragement and his permission to use our method on one of his cases; and to Professor J. B. Duguid for his help in the presentation of this paper. For the supply of Promanide we are indebted to Professor Tytler and to the manufacturers, Messrs. Parke, Davis and Co.

MEETINGS OF SOCIETIES

JOINT TUBERCULOSIS COUNCIL

A MEETING of the Council was held on Saturday, November 21, 1942, at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1. *Present:* Drs. H. J. Burrows, N. England, P. W. Edwards, Emrys Jones, J. Ferguson, A. P. Ford, A. S. Hall, E. Houghton, F. R. G. Heaf, G. Jessel, G. Lissant Cox, R. L. Midgley, Norman F. Smith, N. Lloyd Rusby, V. Ryan, A. Sandison, N. Tattersall, J. Watt (Chairman), R. A. Young, and the Honorary Secretary.

The minutes of the meeting held on Saturday, September 19, 1942, were confirmed with the substitution of "Radiologist" for "Radiographer" in para. 2 (Radiology).

The Chairman referred to the death of Dr. Blackmore, a former member of the Council, who had done so much valuable work for the Council, and expressed on behalf of all members deep sympathy with the relatives of Dr. Blackmore. The Secretary was instructed to send a message of sympathy.

The Chairman welcomed Dr. A. S. Hall (Tuberculosis Association), Dr. Emrys Jones (Welsh National Memorial Association—*vice* Dr. Gilchrist resigned), and Dr. Vincent Ryan (Yorkshire Tuberculosis Society), to the Council.

1. *Correspondence.*—(*a*) Apologies for absence were received from Drs. D. P. Powell, H. G. Trayer, D. P. Sutherland, E. Ward, W. Dickenson, R. A. Dixon, R. R. Trail, P. Kerley, W. T. Munro and Professor W. H. Tytler.

(*b*) Letter from the Secretary of the Tuberculosis Association requesting that the Joint Tuberculosis Council prepare a memorandum on the reorganisation of the Tuberculosis Services in the light of the recommendations of the Medical Research Council. It was resolved that the following committee be set up to consider and report on the organisation of the Tuberculosis Service in Great Britain: Drs. N. England (convener), Lloyd Rusby, A. S. Hall, G. Lissant Cox, Emrys Jones, Peter Edwards and R. L. Midgley. It was agreed that Dr. Cameron be co-opted to this committee to represent Scotland, and the committee were given power to co-opt other members if necessary.

(*c*) Letter from Dr. England asking whether the Council could devise a method of confirming the American claims on the use of Vitamin K in the treatment of hæmoptysis. Dr. Norman Smith suggested that he might be able to report further on this matter, which would be considered by the special department of the Ministry of Health, and it was decided to leave the question open until Dr. Smith had reported back to the Council.

(*d*) The Honorary Secretary raised the question of the investigation of tuberculosis and industrial employment generally. The matter had been put to him in a private communication from Dr. H. B. Morgan, M.P., and he felt that the Council might wish to make this the subject of a special investigation. The Council felt, however, that this was a matter which could be within the scope of the Medical Research Council to investigate, and it was decided to leave the matter in abeyance for the present.

(*e*) Letter from the County Medical Officer, West Riding, Yorkshire, intimating that the County Council would have no objection to Dr. Ryan attending meetings of the Joint Tuberculosis Council, provided he had sufficient staff to deputise for him during his absence.

2. *Nomination of Officers for* 1943.—The following were nominated: Chairman, Dr. James Watt (Godalming); Vice-Chairmen, Dr. D. P. Sutherland (Manchester), Dr. N. Tattersall (Leeds); Honorary Treasurer, Dr. G. Jessel (Lancashire); Honorary Auditor, Dr. D. P. Sutherland (Manchester); Honorary Secretary, Dr. J. B. McDougall (Kent).

It was resolved that the Chairman, Honorary Treasurer and Honorary Secretary be the representatives of the Joint Tuberculosis Council on the Committee to discuss proposals for amalgamation with the two other bodies, the National Association for the Prevention of Tuberculosis and the Tuberculosis Association; the two Vice-Chairmen to be in reserve.

3. *Recent Development in the Anti-Tuberculosis Campaign.*—The Honorary Secretary set out the summary of the recommendations of the Medical Research Council in their report on "Tuberculosis in Wartime," and also gave a verbatim report of the statement made by the Minister of Health in the House of Commons on October 8, 1942.

The Council then proceeded to discuss the Medical Research Council's recommendations paragraph by paragraph.

Dr. Jessel gave an account of the work of the sub-committee on radiology of the Standing Advisory Committee to the Ministry of Health. He emphasised the importance of central direction and guidance, portability, propaganda and publicity. The desirability of the new apparatus being mobile as distinct from being "portable" was stressed by several members. Dr. Heaf also referred to the tendency to divert mass radiology into the smaller voluntary channels and suggested that the local authorities must take the administrative action which would lead to mass radiological investigation. Several members referred to the possibility of overloading the tuberculosis dispensaries with work from the flood of new cases which would be sent. But there was general agreement that the problems concerning the staffing of dispensaries would have to be most carefully considered by local authorities.

During the general discussion reference was made to the dull repetition of much of the routine work in mass radiology and to the necessity of concentrating on older age groups as a likely source for the discovery of new open cases.

The Honorary Secretary explained that it was likely that the financial arrangements forecast by the Ministry of Health would come before the Standing Advisory Committee to the Ministry of Health and that, until the scale was known, no useful purpose would result from any discussion at the present moment. The need for safeguarding the Tuberculosis Officer from laborious assessment on a purely financial field was reiterated and agreed upon by all members of the Council.

The Council felt that the recommendation of the Medical Research Council to the effect that children under five years should be intensively investigated was not intended to signify chest examination so much as observation from the preventive standpoint, since recent figures pointed to a sub-

stantial increase in the incidence of non-pulmonary tuberculosis, probably as a result of massive infection in this age group.

The Council expressed their general agreement with the report of the Medical Research Council.

4. *Travelling Expenses for Members.*—It was resolved that members of the Council attending special meetings should be paid, on application, first-class travelling expenses, plus 10s. 6d. per night away from home, and that this be a first charge on the Ministry of Health grant.

5. It was intimated that the following reports were likely to come before the Council at the next meeting: (*a*) Nursing Committee (Dr. Trayer, convener); (*b*) Tuberculosis in Wartime (Chairman, convener); (*c*) Nutrition (Dr. Munro, convener); (*d*) Institutional Treatment of Children (Dr. Munro, convener).

6. *Date of Next Meeting.*—It was decided to hold the next meeting on Saturday, February 20, 1943.

REVIEWS OF BOOKS

Pulmonary Tuberculosis and its Treatment. By HANS JACOB USTVEDT, M.D. (Oslo). Translated from Norwegian by A. L. Jacobs. London: John Bale and Staples, Ltd., July, 1942. Price 25s.

This excellent book of some 230 pages originated in a series of lectures delivered to medical students in Oslo; these have been expanded and elaborated and now produced in book form. As such it is primarily intended for students and general practitioners; however, it should have a much wider appeal than this, especially in countries other than Norway. It should prove particularly interesting to all workers in this country at the present time when much discussion centres around post-war planning.

In Norway the problem is, to a certain extent, simpler than in other countries as bovine tuberculosis has been entirely eradicated. Even so, in a country where bovine tuberculosis is prevalent, such as Germany, 90 per cent. of primary complexes occur in the lung and are presumably of human origin. The control of the bovine element, although of importance, would have little effect upon the whole problem of tuberculosis in this country. Tuberculin sensitivity has been much more widely employed and for longer periods than in this country, and much information of interest and speculative value is recorded. The intensive anti-tuberculosis campaign has had some effect in displacing the period of infection from childhood towards adult life, but at present it has not been able to prevent infection, for nearly 100 per cent. of the population have a positive reaction by the time they are forty years of age. Forty years is an age very much higher than that found in most countries, and it will be interesting to see whether a continuance or intensification of the Norwegian programme will eventually lead to an actual reduction in the incidence of tuberculous disease. That such a displacement towards adult life is desirable still requires proof, as it is a question of very great importance. An excellent account of the clinical and radiological manifestations of the primary complex is given and accompanied by good radiographs. Interesting

observations follow on the time relations between the primary infection and the onset of the later manifestations of tuberculous disease. Cases of erythema nodosum are reviewed, and it was found " that nearly 10 per cent. develop pleurisy during the first year after infection." In addition there is " quite a high morbidity from other tuberculous conditions (meningitis, phthisis, bone and joint tuberculosis) during the first few years." Again, amongst nurses, a morbidity of 153 per thousand observation years appeared in an originally tuberculin-negative group (including not only primary infection but phthisis and other grave forms of tuberculosis) compared with 8·5 per thousand amongst positive reactors. Amongst the former group there were ten deaths from tuberculosis compared with none in the latter. All the evidence points to " a very short time interval between tuberculous infection on the one hand and tuberculous disease and death on the other."

Of considerable importance is the question of the rôle that superinfection plays in the subsequent development of tuberculous disease. The author believes that its importance is generally overrated but does not deny its occurrence. He believes that the new focus arises by hæmatogenous spread from an infected bronchial gland of the primary complex. Living tubercle bacilli have been found in calcified glands in approximately one-third of all cases examined. If superinfection plays only a minor part in the development of tuberculous disease inoculation with B.C.G. vaccine should assume an important place in prophylaxis, and it is interesting to note that in a group of tuberculin-negative probationer nurses the morbidity from tuberculosis was reduced to the same level as a control group of tuberculin-positive nurses by such inoculation. The whole question is one of vital importance in the battle against the tubercle bacillus.

An excellent and well-illustrated account of the pathology, clinical and radiographical features, complications and investigations is given in simple, lucid style, with due emphasis laid upon essentials and little time given to unnecessary detail. The X-ray illustrations have, unfortunately, been reproduced from illustrations salvaged from Norway rather than from the original films and, consequently, have lost something in the transfer. However, apart from a slight granularity, they are good, and those employed to illustrate the section on differential diagnosis are extremely well chosen. The employment of opaque meals and enemata to reveal intestinal lesions is claimed successful in some 90 per cent. of cases. This method should prove valuable in determining the cause of a chronic diarrhœa in the tuberculous, for other investigations, including the finding of tubercle bacilli in the fæces, are notoriously inconclusive.

The section on treatment forms a departure from the usual consideration of general followed by specific measures. In dealing with serious forms of tuberculosis one is faced with the one central question of whether effective collapse therapy is possible or not so that it becomes more profitable to concentrate attention on collapse therapy and its possibilities. A well balanced and full account of all aspects of collapse therapy is given. With pneumothorax the author emphasises the value of early employment of treatment and equally early abandonment of the unsatisfactory pneumothorax. He shows that the outlook for the contraselective pneumothorax is worse than that of similar patients without pneumothorax, due, no doubt, to the high incidence of a complicating pyo-pneumothorax in the former group. On general treatment he refers to the employment of occupational therapy, a feature whose importance is becoming more widely recognised in this country at the present time.

The book concludes with a short but valuable section on prophylaxis in which the author emphasises the importance of determining the time of infection by regularly repeated tuberculin tests of the population, followed by repeated observation over a period of several years of all who, originally negative, become tuberculin-positive. The elimination of bovine infection, complete protection during infancy when resistance is low, attention to nutrition of the poorer sections of the community, and perhaps the use of B.C.G. vaccine, are a series of powerful and important weapons in the fight against tuberculous disease.

The author has considered in a most practical and instructive manner both the theoretical and practical aspects of tuberculous infection and disease. The book should prove invaluable to the recent graduate and the general practitioner as well as holding much in store for the regular worker; it is, indeed, a pleasure to read such a fair-minded and clear discussion of tuberculosis problems from all aspects.

Modern Aspects of the Antituberculosis Program. By J. Burns Amberson, Kendall Emerson, Wm. Charles White and Louis I. Dublin. University of Pennsylvania Bicentennial Conference, 1941.

This brief survey of a national attack on a vital problem aims at nothing less than perfection. The professed aim of all four writers is the eradication of tuberculosis.

Professor Amberson, in discussing the evaluation of the early lesion, stresses the need for its early recognition. "It is not enough to teach the sufferer to seek the doctor, but . . . the doctor must be trained to go out and find the unsuspecting sufferer." This should not be impracticable since, although symptomatic tuberculosis is usually advanced, and has been infectious for a considerable time, the pulmonary lesion is radiologically demonstrable at a considerably earlier stage. The natural corollary to early diagnosis is early treatment, both for the benefit of the sufferer and to prevent infection among his associates. Even though present methods of diagnosis should be much more widely applied to this problem, there is a need for new methods to afford still earlier diagnosis.

Dr. Emerson, from the point of view of a public health agency, illustrates the more direct attack on the public by education, first in a healthy fear of the disease, and secondly in self-protection by general hygiene. A most important problem which is dealt with by the same agency is the after-care and rehabilitation of treated patients. No amount of early diagnosis and treatment can achieve the desired end if discharged patients must return to the conditions of poverty and malnutrition in which the disease first took root. Here, however, one would like to see more weight attached to the need for economic and social reform to eradicate those conditions which predispose to infection and spread of the disease. This form of domestic attack should be complementary to the clinical and laboratory attack on the bacillus.

The two main lines of attack, diagnosis and treatment, must both be forwarded by research. The most profitable lines of inquiry for the first are radiology and skin testing, in both of which research is improving technique. With regard to specific treatment there are both wider gaps in our knowledge and more possibilities of approach, as shown by recent research. The chemical induction of tubercle formation and even caseation in animal inoculation experiments suggests the possibility of effective chemotherapy, while the search for a phagocytic amœboid cell suitable for exhibition in the human body is

being actively pursued. The involuntary research of observant clinicians continues side by side with laboratory experiments.

How far all these efforts have advanced the fight against tuberculosis is suggested by Dr. Louis I. Dublin's statistics. It would be encouraging to believe his statement that " the disease is obviously on the run and, if we would only concentrate our armaments and intensify our efforts, it would be a matter of relatively few years, not over twenty, I believe, before complete success would crown our work." This is followed, however, by a warning, more forcibly expressed by Dr. Emerson, that progress is not inevitable. Our present position cannot be even maintained, far less advanced, without continual effort by the majority of the people.

This book adds nothing to our knowledge of the disease (that is not its purpose), but upholds as a practical possibility the eradication of a disease which is still responsible for 5 per cent. of all deaths in the U.S.A.

Erratum.—Vol. XXXVI, No. 4, Plates XXVI and XXVII: The illustrations of Figs. 6 and 7 should be transposed.

BACK NUMBERS AND SALVAGE

Please read this carefully.

At the present time when people are being advised and exhorted to clear out their attics and cupboards, it is probable that back numbers of the British Journal of Tuberculosis will be put out as " salvage " and be destroyed.

Before this takes place, the Publishers would like to have the chance of looking them over in case any of the parts may have a value, in which event they will make a payment for any copies which may be kept.

Will our readers, therefore, look at their " glory-holes " and see if they have any old parts lying by, and also at their shelves and make up their minds if they wish to keep all the back volumes. In either case, any unwanted loose parts and any unwanted bound volumes may be sent carriage free to the Publishers, Messrs. Ballière, Tindall and Cox, 8, Henrietta Street, Covent Garden, London, W.C.2. If there are not sufficient to warrant sending the journals by rail, parcel post may be used and the Publishers will refund the postage. All unwanted parts will be sent to salvage.